AIR ENGINEERING

JULY, 1961
VOL. 3, NO. 7

AIR QUALITY CONTROL . . . FOR COMFORT, PROCESS AND PROFIT

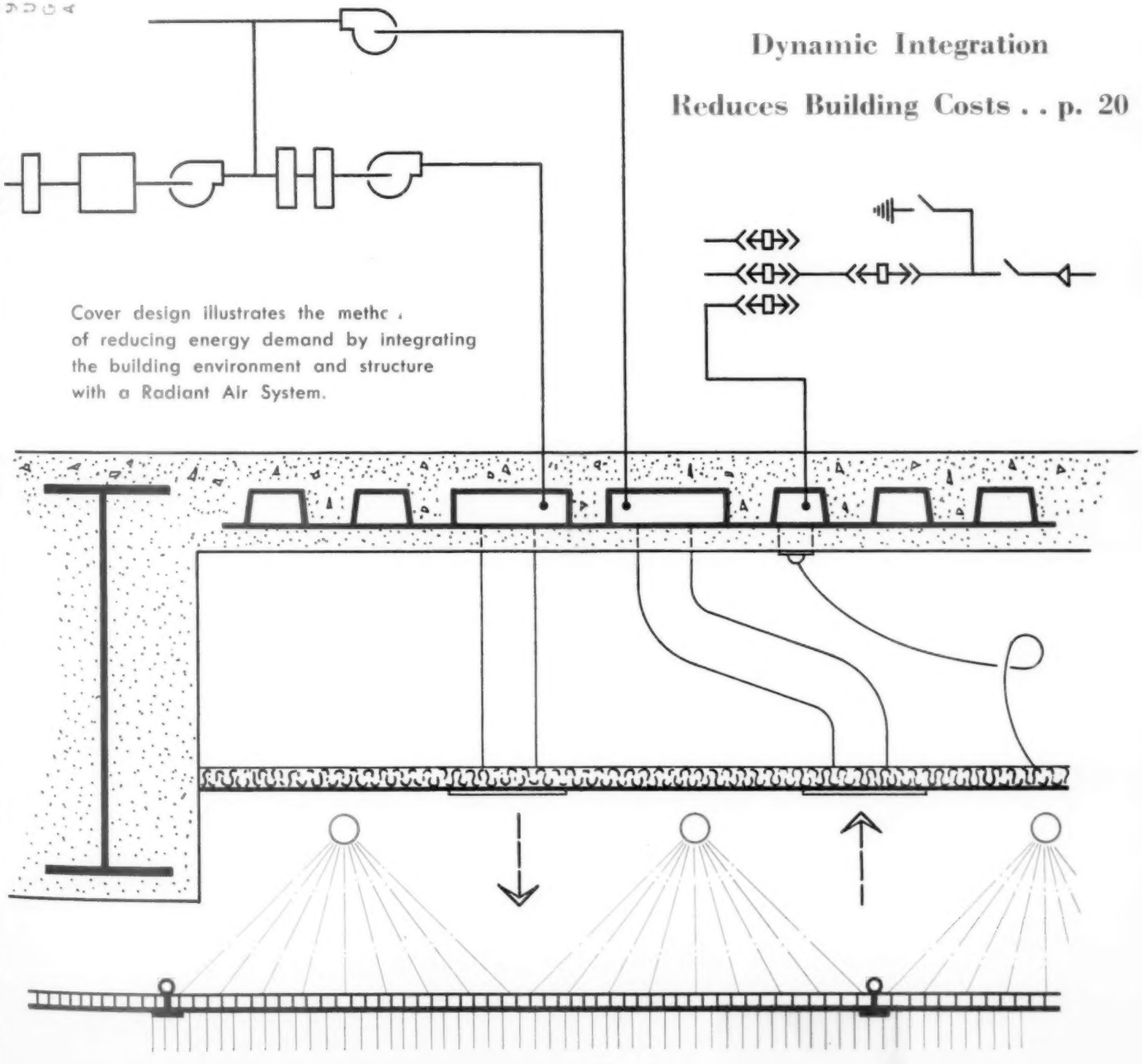
- Reducing Costs By Combining Radiant Air System With New Cellular Air Floor p. 20
- Industrial Heat Exposure And Control p. 21
- Application Of Wet Scrubbers In Industrial Cleaning p. 27
- Air Conditioning A Solid Propellant Factory p. 38

9636 I -20 IYRI
UNIVERSITY OF MICHIGAN
GENERAL LIBRARY
ANN ARBOR MICH

UNIVERSITY OF MICHIGAN
JUL 12 1961
THE UNIVERSITY OF MICHIGAN
ARCHITECTURE LIBRARY
JUL 19 1961
ENGINEERING LIBRARY

Dynamic Integration

Reduces Building Costs . . p. 20



Cover design illustrates the method of reducing energy demand by integrating the building environment and structure with a Radiant Air System.

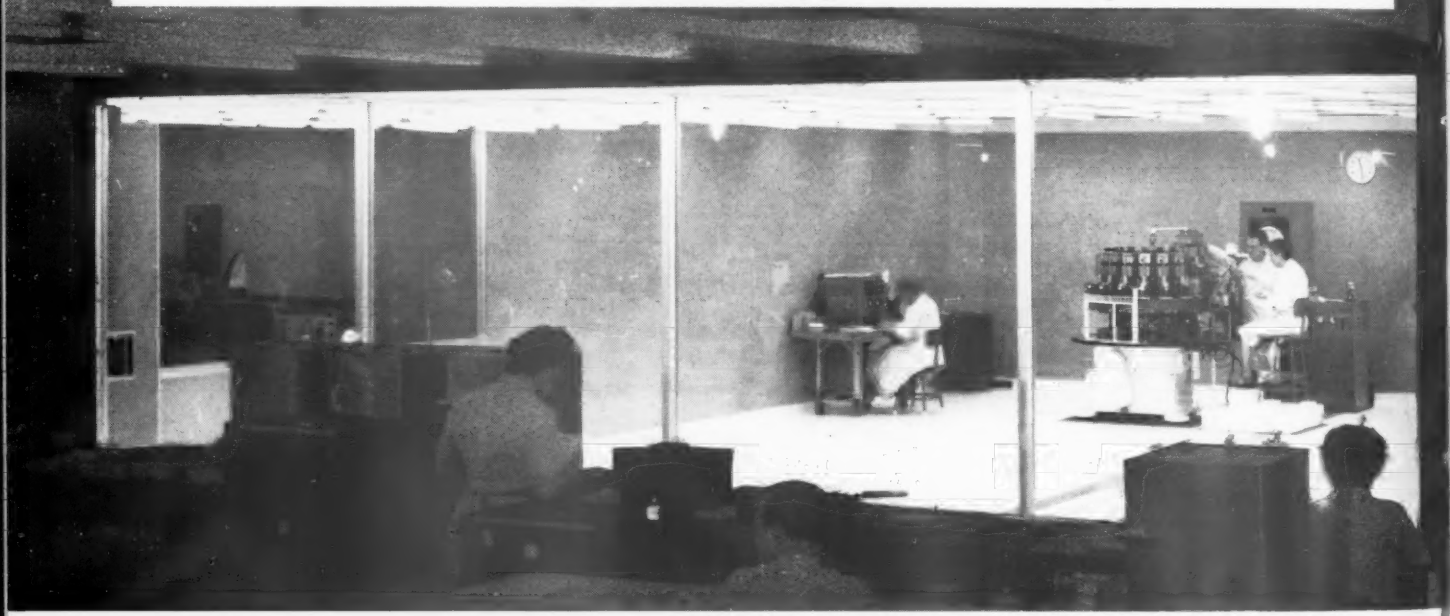
AAF keeps white-room air *white-room clean!*

3-step air cleaning system utilizes three different types of AAF filters

1 AIR COMING INTO C. P. CLARE OFFICE AND PLANT is cleaned by completely automatic AAF Electro-Matic electronic precipitators.

2 INTAKE AIR FOR AAF Kennard/Nelson AIR CONDITIONING UNIT serving white room is further cleaned by AAF Electro-PL filters which combine the principles of electronic and dry-type filtration.

3 AIR ACTUALLY ENTERING WHITE ROOM is filtered by AAF high-efficiency Type F filters enclosed in the duct running from the outlet of the air conditioning unit to the white room.



Architects: Rapp & Rapp, Chicago; Consulting Engineers: J. P. Bazzoni & Co., Chicago.

White room operations involving the assembly of electrical relays demand ultra-clean air and rigidly controlled temperature and humidity. The planners of the new addition at C. P. Clare Co., Chicago, determined that their white room should have a complete air system all its own. Logically, they turned to AAF. Result: white-room air to white-room standards—99.97% dust-free, constant 72° temperature, and controlled humidity.

This white room system points up AAF's capacity for clean-air engineering. Only AAF makes *all kinds* of filters. Thus, AAF can always fit the right filter (or combination of filters) to the needs of the specific air-cleaning job.

For information on all the AAF products in operation at the Clare plant, call your local AAF representative or write us direct. Address: Robert Moore, American Air Filter Co., Inc., 305 Central Ave., Louisville, Ky. In Canada: American Air Filter of Canada, Ltd., 400 Stinson Blvd., Montreal 9.

AAF **American Air Filter**

BETTER AIR IS OUR BUSINESS

AFI MEMBER

[For more information circle #11 on page 35 reply cards]

AIR ENGINEERING

VOL. 3, NO. 7

JULY, 1961

AIR QUALITY CONTROL . . . FOR COMFORT, PROCESS, PROFIT

FEATURES

How To Reduce Costs By Combining Radiant Air System With New Cellular Air Floor 20

by Gershon Meckler, P. E., Meckler Engineering Co., Toledo, Ohio, John S. Hickman, Engineered Products Div., Inland Steel Products Co., Milwaukee, Wis., and Milton Meckler, P. E., Meckler Engineering Co. Using specific job examples, a discussion on how by careful analysis of building design heat gains can be turned into cooling gains and also the reverse.

Industrial Heat Exposure and Control 24

by Robert Lemke, Mechanical Engineer. First part of a series outlining sources of heat in industry, how to calculate effect of this on the worker, and what to do about removing, alleviating or otherwise keeping the worker cool.

Application Of Wet Scrubbers In Industrial Gas Cleaning 27

by Gordon T. Nicklin, Chemical Engineer, Western Precipitation Corp., Los Angeles, Calif. Summarizes performance characteristics of scrubbers in low, intermediate and high pressure drop categories with emphasis placed on impingement type.

Air Conditioning A Solid Propellant Factory 38

by William Higgins, Executive Staff Engineer, Rocket Power Division, Gabriel Corp. How plant solved a close temperature and humidity control problem.

DEPARTMENTS

Editorial 7
Meetings 8
Next Month 9
Letters 11
News of the Industry..... 16
New Products 30
New Literature 34
Communications Center 35
Classified Ads 44
Advertisers Index 44

COVER

Illustrates the marriage of Building Structure with the Lighting and Air Conditioning Systems. Cover art work by Alfred E. Hoertz, Jr., Meckler Engineering Co., Toledo, Ohio.

AIR ENGINEERING is published monthly by Business News Publishing Company, at 450 West Fort Street, Detroit 26, Michigan. Subscription prices: United States, Canada: $3.00—1 year; $4.50—2 years; $6.00—3 years. Foreign: $5.00—1 year; $8.50—2 years; $12.00—3 years. Single copies 50 cents. Second-class postage paid at Detroit, Michigan. First issue April, 1959. • CHANGE OF ADDRESS. Notify AIR ENGINEERING and your local Post Office of both your old and new addresses including postal zone numbers by 12th of preceding month.

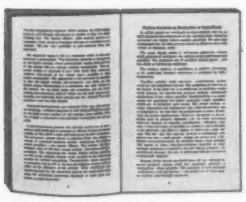
• CONTENTS COPYRIGHT 1961 by Business News Publishing Company. Reproduction of material may not be made without written permission of the publisher.

Eliminate fumes and odors and save!

Keeping the precious envelope of air surrounding the earth free and clean is a practical objective in itself. Catalytic Combustion systems do this and much more by providing efficient elimination of noxious fumes and odors, plus the recovery of heat energy. Designed for industrial processes exhausting fumes, Catalytic's systems provide an attractive payout, and often furnish substantial operating profits as a result of the recovery of heat energy released in the catalytic process.

Flameless combustion is accomplished at low temperatures by a specially designed all-metal catalyst. When applied to fume streams containing high potential fuel energy, heat recovery provides a payout covering the cost of the equipment in a matter of months. Air correction values, though not as easily measured, provide a full range of benefits including: improved plant safety, improved employee morale, more pleasant working conditions, and improved community goodwill. Industrial plants are able to effectively eliminate noxious fumes and odors from process exhausts, preventing costly plant relocation.

Catalytic Combustion elements are built to standard sizes and complete systems are custom-engineered for maximum effectiveness. Catalytic systems meet Air Pollution control standards and insurance requirements.



Learn the facts *about fume and odor control . . . and the benefits of a Catalytic System. Send for our descriptive brochure, write "Department D."*

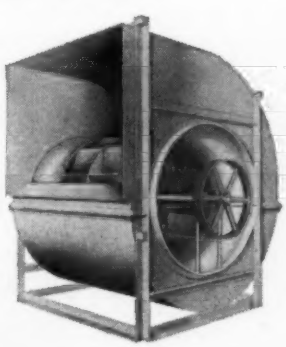
CATALYTIC COMBUSTION CORPORATION
4725 Fourteenth Street • Detroit 8, Michigan
A SUBSIDIARY OF UNIVERSAL OIL PRODUCTS COMPANY

[For more information circle #14 on page 35 reply cards]

Feather-floating zephyr to tropical hurricane velocity . . . you name it, and specially controlled Peerless Air Moving Equipment provides it on cue. All-welded construction keeps housing and scroll firm and quiet. Obstruction-free inlets allow air to pass through the unit at unimpeded peak efficiency. Welded wheels are statically and dynamically balanced for perfect rotation. Engineers! You can specify Peerless with confidence. Contractors! You can install Peerless with ease and assurance. Users reap the benefits of quiet, dependable, inconspicuous service.

Investigate Peerless Air Moving Equipment Today! Write to Peerless Electric Division, H. K. Porter Company, Inc., 1404 West Market St., Warren, Ohio.

Manufactured and sold in the western states by Master Fan Corporation, H. K. Porter Company, Inc., 1323 Channing Street, Los Angeles 21, California. NOW AVAILABLE—Centrifugal Blowers to 132" wheel diameter, Turbo Blowers to 55" S. P., Tube and Vaneaxial Blowers and Industrial Fans to 104" wheel diameter.



PORTER **PEERLESS ELECTRIC DIVISION**
H. K. PORTER COMPANY, INC.

Member—Air Moving and Conditioning Association, Inc.

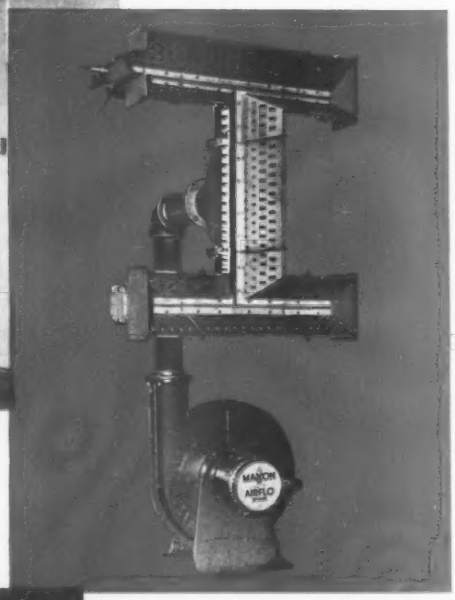
[For more information circle #15 on page 35 reply cards]

keep weather out, plant heat in,

with HOT AIR DOOR CURTAINS using MAXON AIRFLO Burner Systems

Open doors need no longer cost heat losses, cause discomfort or inconvenience. A Hot Air "curtain" or "screen" directed across the opening when the door is opened keeps warm air inside and cold, blustery air outside.

MAXON AIRFLO Burner Systems, with gas burned directly in the air stream, assure maximum combustion efficiency and most economical heat source. Automatically actuated when the door is opened, the AIRFLO Burner System heats the flow of air only when it is needed.



Hot Air Door Curtains can be tailored to your particular conditions and needs. Ask a MAXON Application Engineer, or write today for data sheets and other information.

MAXON

MAXON PREMIX BURNER COMPANY
MUNCIE, INDIANA

Ad No. 71

[For more information circle #16 on page 35 reply cards]

AIR | ENGINEERING

Publisher: E. L. Henderson
Assistant Publishing Manager: P. A. Schildhammer
Editor: Eugene A. Sloane
Assistant Editor: George M. Hanning
Assistant Editor: Beverly Green
Research Manager: John A. MacLean
Advertising Manager: Alfred Chadburn
Advertising Production Manager: A. M. Barrow
Circulation Manager: R. M. Ashley
REPRESENTATIVES: NEW YORK 17—521 Fifth Ave., MUrray Hill 2-1928-9, R. M. Price, F. L. Taylor.
CHICAGO 3—134 S. LaSalle St., FRanklin 2-8643-4, M. R. Smith, D. Ryden.
DETROIT 26—450 W. Fort St., WOodward 2-0924, Alfred Chadburn.
LOS ANGELES 43—4710 Crenshaw Blvd., AXminster 2-9501, J. A. Hannon.
MEMBER: Associated Business Publications, Audit Bureau of Circulations

EDITORIAL:

Federal Vs Local Air Pollution Control . . .

SHOULD AIR POLLUTION be controlled by city, state or the Federal Government?

The answer is not simple, nor is there a universally applicable solution.

In favor of purely local municipal control is the fact that within city confines the combination of air pollutants, meteorological forces, topography, ability of local control people, the liberality of their operating budget and political climate, are unique and probably not duplicated anywhere else on earth.

These purely local conditions may or may not mean that the same solution to a given control problem will work in every city.

Flat terrain and high winds which prevail away from occupied areas, may for example, permit a lower cost control installation, whereas a ring of hills and poor natural ventilation may require, as in the case of Southern California, stringent and more costly measures to solve the same problem.

In favor of inter-city or county-wide jurisdiction of control authorities (as in the case of Milwaukee county, Wisconsin, Los Angeles county and the San Francisco Bay Area), are air pollution control problems which affect a wide area in which lie many municipalities. County(ies) control authority set-up permits pooling of financial resources for a mutually adequate research and source testing program and the hiring of trained personnel to assist industry in their air pollution control efforts.

Where city or county government will not or cannot cope with air pollution, the State government should take over, until it can lead local governments to act on their own.

Where pollution crosses city borders, and adjoining cities will not cooperate, as in the case of Detroit and certain of her satellite communities . . . or where pollution crosses state borders, as between New York and New Jersey, Ohio and West Virginia, control efforts should be undertaken by states. In the case of inter-city problems, the states should have a sound minimum air pollution code, to which all cities must

(Please turn to following page)

Editorial *(Cont.)*

(Continued from preceding page)

adhere, just as most states today have sound minimum plumbing and building codes to safeguard the health of their citizens in case municipalities do not have adequate codes on their statute books.

In the case of inter-state problems, adequate solutions seem to be in process now, although certainly should these not materialize soon, it would seem that the Federal government could serve as mediator, just as it does today in the case of labor disputes (although it is to be hoped with more success).

What, then, remains as the role of the Federal government, specifically the United States Public Health Service, in controlling air pollution throughout the nation?

The U.S.P.H.S. is, as it should be, doing a considerable amount of basic research on specific pollution control problems at its excellent Robert A. Taft Sanitary Engineering Laboratories in Cincinnati, Ohio. It also supports, by grants-in-aid, air pollution research on control problems and their health aspects at universities.

U.S.P.H.S. operates the National Air Sampling Network and so monitors the air across the nation. All of these activities are certainly best done at the Federal level, since neither city or most states have the funds, or the need, to carry on most of them. Business firms certainly should not be expected to carry on this work, since it has so very tenuous, if any, relation to profits.

Despite all of the needed control programs now underway under the aegis of the U.S.P.H.S., there is much that needs to be done by the U.S.P.H.S. at the city level.

The best manned city air pollution control authority, without adequate funds, cannot ever hope to get to the heart of its control problems. Without proper instruments to detect, analyze and probe (and they are costly), without a staff to use these instruments, the best air pollution control code is worthless.

Rather than wait until city fathers are sold (or pushed by the citizenry) into furnishing an adequate budget, they should be given an incentive to increase the air pollution control budget through matching funds from the U.S.P.H.S.

For example, New York City tries to operate an air control department with a budget of only $700,000, while Los Angeles has a budget of some $3-million. Most cities in this country have a pitifully small budget for air pollution control, yet the need for control has never been more urgent.

Burgeoning industry has plenty of problems to cope with besides the non-profit one of air pollution, yet no one claims they should *not* pay for it. Moreover, the government has allowed rapid amortization, liberal tax write-offs, for other industrial expenses incurred in the public interest . . . why not for air pollution control equipment? This tax allowance is another role the Federal government could play in the control of air pollution.

In all of these State and Federal control activities which impinge on the local community, there should be adequate safeguards against Federal interference. If the U.S.P.H.S. determines that need for funds exists in a given city, it should give these funds without strings, making sure only that at least one qualified person is on the local staff so the funds will be properly used.

If tax allowances be enacted by the Congress, question as to whether or not a given piece of equipment is in truth for air pollution control and not product recovery as well, should be determinable by local authorities, and only if none is available, by State or a qualified consulting engineer employed by the State for this purpose.

Properly staffed and equipped city air pollution control programs will protect industry against the lunatic fringe who would push politicians into rash and hasty action that could be most costly to industry. Well-planned and implemented air pollution control programs give industry time to solve pollution problems through test, research and pilot operations, without which thousands of dollars may be lost on unworkable control programs.

Thus, City, State and Federal governments can cooperate to solve local problems on a local basis, and thereby serve citizens, both private and corporate, best through intelligent, not rash, action. ▲▲

Eugene A. Sloane

Editor

Meetings

Western Plant Maintenance and Engineering Show, *Pan Pacific Auditorium, Los Angeles, Calif., July 18-20, 1961.*

4th International Conference on Bio-Medical Electronics; 14th Conference on Electronic Techniques in Medicine & Biology, *Waldorf-Astoria Hotel, New York, July 9-14, 1961.*

Atomic Shelter Seminar, *The Pennsylvania State University, University Park, Pennsylvania, July 10-22, 1961.*

Joint Nuclear Instrumentation Symposium, *North Carolina State College, Raleigh, N. C., Sept. 6-8, 1961.*

Production Engineering Show, *Navy Pier, Chicago, Illinois, September 6-16, 1961.*

ISA Fall Instrument-Automation Conference & Exhibit, *Memorial Sports Arena, Los Angeles, Sept. 11-15, 1961.*

First International Convention on Ionization of Air, Technical, Physical and Physiological Aspects, *Ben Franklin Institute, Philadelphia, Pennsylvania, October 16-17, 1961.*

National Metal Exposition, *Detroit, October 23-27, 1961.*

Air-Conditioning and Refrigeration Institute (annual meeting), *The Homestead, Hot Springs, Virginia, Nov. 12-15, 1961.*

National Warm Air Heating and Air Conditioning Assn. (annual convention), *La Salle Hotel, Chicago, Nov. 13-16, 1961.*

Letters

Would Like Survey On "Equal" Brand Bidding

Editor:

I would appreciate your making a survey of mechanical engineers to get answers to the following questions:

1. When the specification reads "Brand A, B, or equal shall be furnished," what percentage of the time do "equal" brands actually receive approval?

2. When the specification reads "Furnish Brand A or show add or deduct for equal brands," what percentage of the time are "add or deduct" brands actually approved?

3. How would mechanical engineers answering the above questions feel about a new system on public jobs which would be similar to the system used by many large industrial firms? That is, bids are taken direct from suppliers on a completely open specification. Equipment is evaluated by the engineers from a standpoint of both quality and cost, and a decision is made as to exactly the brands of equipment to be used. Then the job is advertised to the contracting trade with a closed specification specifying brands previously selected.

4. Do they feel that the present state of affairs, especially as experienced in the heating and ventilating trades, is normal? What percentage of commission do they feel suppliers should make on the sale of equipment to contractors in the mechanical trades?

B.C.A.

Editor's Note:

We invite our readers to send their answers to B.C.A.'s questions to Editor, AIR ENGINEERING, *450 W. Fort St., Detroit 26, Mich.*

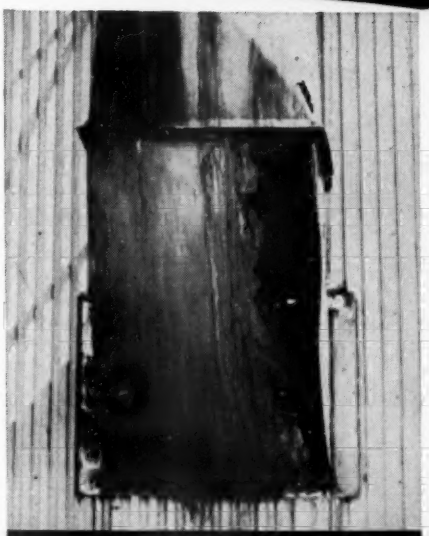
AIR ENGINEERING Recommended To New Subscriber

Editor:

Your publication has been recommended by a member of the air conditioning industry. Up to-date,

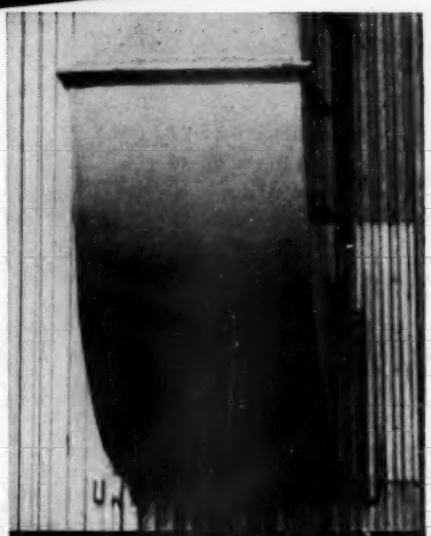
(Please turn to following page)

Take your choice



CORROSION RESISTANT* METAL

*After six months in service



CORROSION PROOF* DURACOR

*After two years in service

LIGHT, STRONG DURACOR REPELS CORROSION BETTER THAN METAL . . . LASTS LONGER . . . COSTS LESS

Duracor reinforced plastic withstands attack from almost every known solvent, alkali, reducing agent or oxidizing acid. It can be sawed, drilled, filed or sanded . . . readily fabricated into pipe, duct, tanks, hoods, and other special equipment. High resistance to heat, flame, chemicals and abrasion makes Duracor ideal for severe corrosive service in the metalworking, textile, paper, food and chemical processing industries. Duracor has a high strength/weight ratio . . . needs no exterior protection. Installation is quick, easy and economical. Duracor is fabricated exclusively by The Ceilcote Company, producers of corrosion-proofing materials for industry for more than 30 years.

CEILCOTE OFFERS DESIGN ASSISTANCE . . . BUILDS AND INSTALLS DURACOR VENTILATING SYSTEMS AND PROCESS EQUIPMENT TO CUSTOMER SPECIFICATIONS

DURACOR PROCESS EQUIPMENT

Tensile Strength p.s.i. (D638-S2T)*	11,000-15,000
Flexural Strength p.s.i. (D790-49T)*	20,000-30,000
Tensile Modulus of Elasticity p.s.i.	1.2-1.4x10⁶
Flexural Modulus of Elasticity p.s.i.	0.78-1.6-10⁶
Coefficient of Linear Expansion	9.5x10⁻⁶ in./in./°F.
†Maximum Temperature (Exposure)	500°F.

DURACOR VENTILATING EQUIPMENT

Tensile Strength p.s.i. (D638-S2T)*	8,000-12,000
Flexural Strength p.s.i. (D790-49T)*	14,000-22,000
Flexural Modulus of Elasticity p.s.i.	0.70-1.4x10⁶
Coefficient of Linear Expansion	10.5x10⁻⁶ in./in./°F.

DURACOR CEILCOTE

THE CEILCOTE COMPANY INCORPORATED

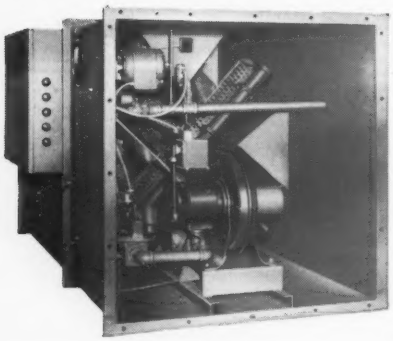
4988 Ridge Road
Cleveland 9, Ohio

Please send me your catalog of DURACOR
☐ VENTILATING SYSTEMS
☐ PROCESS EQUIPMENT
NAME_____TITLE_____
COMPANY_____
ADDRESS_____
CITY_____ZONE_____STATE_____

10100-CC

[For more information circle #17 on page 35 reply cards]

Hartzell can supply the *AIR INTAKE UNIT* that meets your exact requirements



Hartzell intake units are assembled to your order from standard components. You get, and pay for, only the elements you need. Filters and filter house—shutters—outlet diffusers . . . can all be included if you need them, omitted if you don't. Fans and control systems for all operating requirements are readily available. Gas-fired (shown) capacities from 15,000 to 90,000 CFM; steam fired from 4,000 to 36,000 CFM.

For complete details, just give your nearby Hartzell field engineer a call. You'll find him listed in the Yellow Pages or in the Hartzell catalog in Sweet's Plant Engineering and Industrial Construction Files.

Hartzell PROPELLER FAN COMPANY
Division of Castle Hills Corp. • PIQUA, OHIO
A Member of AMCA

[For more information circle #18 on page 35 reply cards]

Letters

(Continued from preceding page)

we have about 4,000 tons of air conditioning installed at this plant with many additional areas to be done before our sixteen acres of floor space can be classed as comfortable the year around.

The enclosed check is to cover a year's subscription to your publication. If possible, date it back to the January, 1961 issue and send the back issues so we can maintain files by calendar years. Please mail all issues to this plant's air conditioning and ventilation engineer, Mr. Charles F. Wieners.

We are also advised that you offer a book on the design and maintenance of dust free rooms, often called white rooms. If so, please advise the title, author and cost thereof. We have a number of these rooms and feel sure we can use a good reference book as treatise on the subject.

S. M. Lieberman
Project Engineer
Philco Corp.
Philadelphia, Pa.

February Article Still Brings Inquiries

Editor:

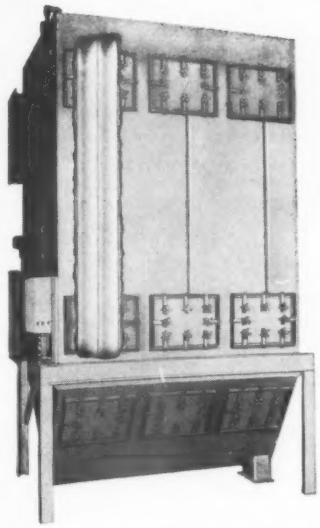
Probably the best way to express our appreciation for the feature story on our Nappi Shoe Decontamination Equipment in the February issue of AIR ENGINEERING is to let you know that we are even at this late date receiving fifteen to twenty inquiries weekly from your readers across the nation and even several from abroad.

We are pleased to announce that since the publication of the article we have effected engineering changes to our unit which virtually assures the ultimate in shoe cleaning protection to white room facilities.

Incidentally, we continually receive inquiries referring to the 'Directory of Suppliers and Equipment for White Rooms.'

C. J. Hamel
Vice-President
Nappi Equipment
Berlin, Conn.

NEW DUSTEX "INDUCTAIRE" FABRIC-FILTER DUST COLLECTOR



Dustex "Inductaire" Filter Collector, Model 20-8-3. Sizes to meet all capacity requirements. Equipped with suitable filter fabrics to handle any dust problem including high temperatures up to 550°. Model shown with 8' bags. Larger models equipped with 12' and 25' bags.

GENTLE BUBBLE-ACTION ELIMINATES THE "DUST TRAP"

- **more effective, shorter cleaning cycle maintains system volume with minimum fluctuation**
- **higher air/cloth ratios in less space greatly reduces first costs**
- **longer fabric life—no damaging shakers or blow-back mechanisms**
- **lower maintenance costs—dampers operate in clean air ducts only—no other moving parts—bag changes easier, less frequent**

Only gentle air action on the fabric—virtual elimination of trapped dust...that's the amazing combination achieved by "Inductaire" bubble-action, introduced by Dustex to reverse air cleaning. No violent shakers, no fabric-damaging friction of any kind...yet, each bag is thoroughly flexed, purging it of the dust usually trapped by reverse air collapsing. Resulting increases in air/cloth ratios, plus many other Dustex engineered features, add up to less space requirements, reduced first costs, lower maintenance and operating expenses. Now, the 99.9+ efficiency of filter collection is yours at savings never before possible!

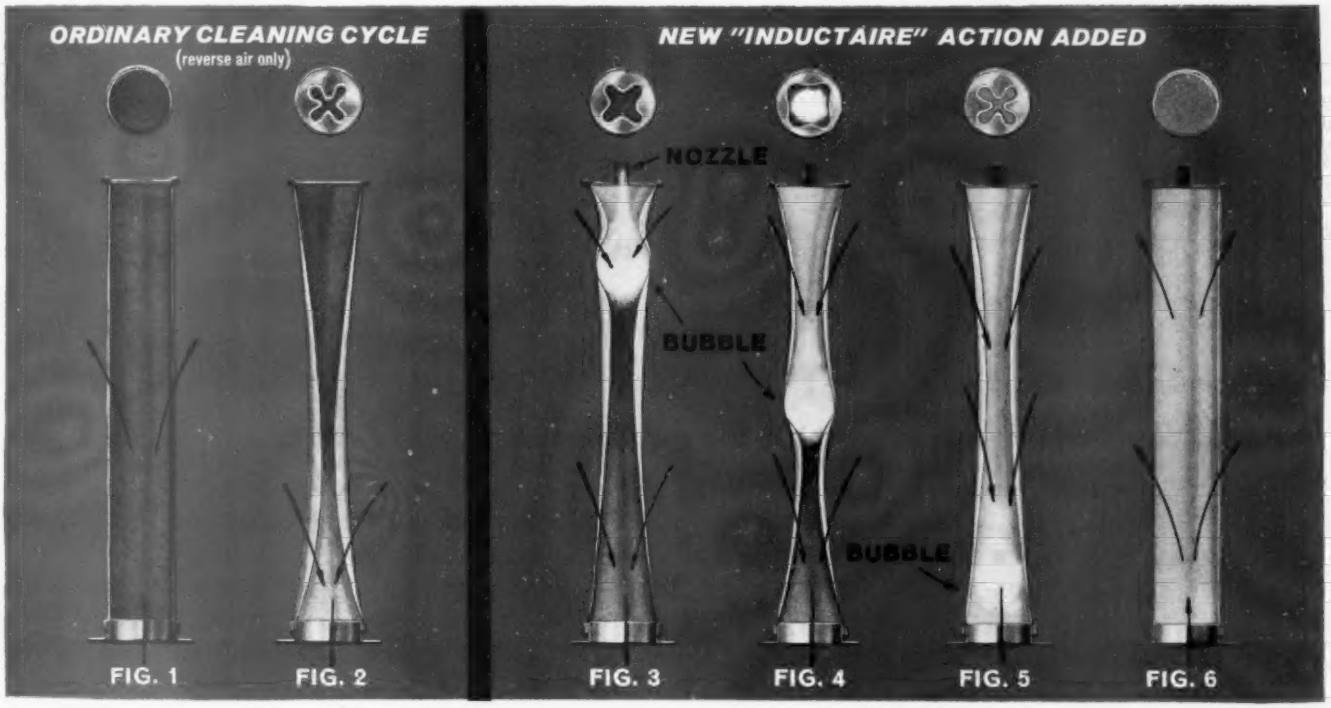


FIG. 1 Dust cake builds up to point where cleaning is required.

FIG. 2 Reverse air flows through fabric, collapsing tube in pleats until only small cone remains at bottom through which air can move. Dust cake is cracked by this action but much of it is trapped in upper portion of tube. This is the usual reverse air system used for many years in collectors capable of air/cloth ratios in the range of 2 cu. ft./sq. ft.

FIGS. 3 & 4 Addition of unique "Inductaire" nozzle in bag cap, increases air/cloth ratios up to 10 cu. ft./sq. ft. and higher. After usual reverse air cycle collapses bag, nozzle releases short pulses of air inducing additional air currents through the top of the bag, creating an air bubble that flows downward, opening the collapsed tube and purging the dust cake into the hopper.

FIG. 5 Reverse air flow continues, causing tube to again collapse producing further cleaning action on the fabric. Steps 3, 4, and 5 then repeat as many times as required (usually 3-5 impulses) for the dust handled.

FIG. 6 The brief cleaning cycle; about 20 seconds, is complete, with the tube back in normal filtering operation.

"Inductaire" represents the latest development by Dustex to offer the finest in filter and centrifugal dust collection equipment for every dust problem. Write for particulars on the complete Dustex line and engineering services ready to help you.

Dustex CORP.

P.O. Box 2520 • BUFFALO 25, NEW YORK

The company with the big name in dust collection

[For more information circle #19 on page 35 reply cards]

Philco Controlled Atmosphere Equipment...

the answer to your stringent requirements!

Complete systems, or component equipment... designed by Philco because no conventional equipment met Philco's own atmosphere control requirements...now production-proved...available at competitive prices—including factory service.

Only Philco equipment gives you all these features:

IN DRY BOXES

External bolting flanges and externally mounted lights eliminate internal obstruction, reduce operator fatigue, and assure more hermetic reliability.

Glove mounting design provides constant O-ring compressive tension at every point in the glove's perimeter—for optimum seal.

Moisture content of 10 parts per million, or less—with a Philco-approved recirculating air dryer.

Philco modular dry boxes are available in "L" and "T" groupings for optimum floor layout flexibility. All models are available in either lowest-permeability stainless steel or aluminum. All seams in all models are heliarc welded. All models contain safety glass windows. Modular and individual dust shields feature the same design advantages.

IN VACUUM OVENS

Single rectangular as well as double and triple tubular oven configurations are available. Philco ovens distribute the most even heat possible to the work load—maintain an even temperature control ±2°C. at 150°C. to ±8°C. at 350°C.—as measured on the inner wall surface.

Vacuum of 5 microns can be reached in less than 10 minutes with recommended mechanical vacuum pump. Higher vacuum is obtainable using optional diffusion pumping systems.

Designed as building blocks for system flexibility, Philco Vacuum ovens are ideally matched with Philco modular dry boxes. They may also be coupled with virtually *any* dry boxes.

Wherever atmosphere control is critical . . . in chemistry, electronics or medicine . . . Philco modular "Building-Block" equipment offers tightest control. For detailed information, write Dept. AE761.

Equipment Development and Manufacturing Operation

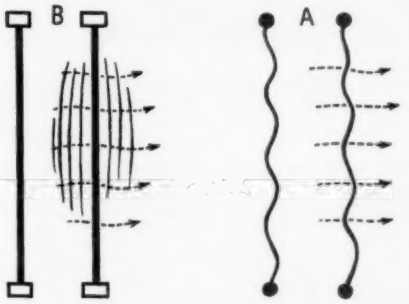
PHILCO®

Famous for Quality the World Over

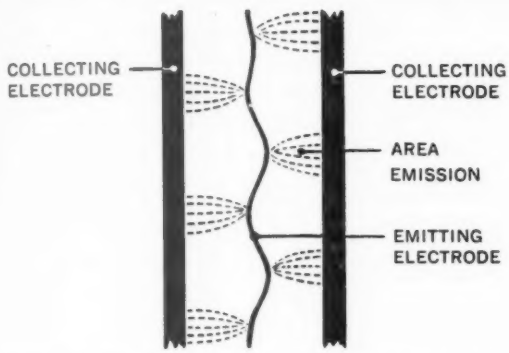
LANSDALE DIVISION, LANSDALE, PA.

SUPERIOR PRECIPITATOR PERFORMANCE

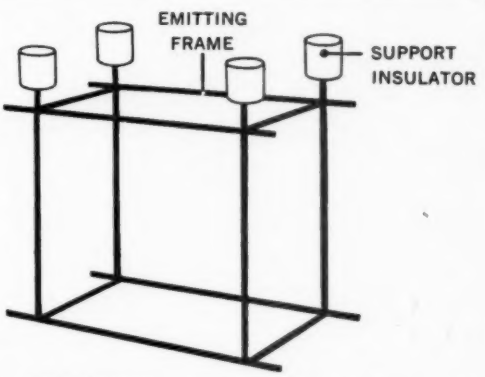
—how it's helped by Buell's exclusive emitting system



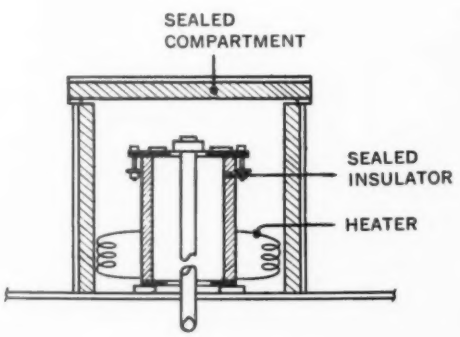
LESS THAN 2% REPLACEMENT — Each stainless steel Buell Spiralectrode is firmly fixed top and bottom to a rigid frame (A). Self-tensioned in this way, the electrode does not sway or lose alignment as shown at (B), even under current surges or varying gas flows. Buell's 10-year replacement record in this critical area is under 2%.



HIGHEST EMISSION—TOP EFFICIENCY — The patented spiral shape of emitting electrodes in the Buell precipitator presents collectors with areas of maximum emission per unit of power input. Because there is no problem of efficiency-destroying misalignment here, you can apply maximum voltage to achieve peak emission.



RUGGED SUSPENSION — Buell SF Electric Precipitators are designed and built to take extremely rugged operating conditions. The emitting frame is constructed of heavy-gauge steel and the whole unit is held rigid by four supporting insulators. Because of this rigid box-type construction, misalignment or arcing is not a problem.



QUARTZ INSULATORS — SEALED COMPARTMENTS — Special temperature- and shock-resistant quartz insulators are sealed in individual compartments. This prevents circulation of dirty gas from the precipitator, without the need for costly ventilating systems. Thermostatically controlled heaters prevent condensation during start-up.

. . . and don't forget the simple, effective, mechanical rapping system, possible only because rugged Buell construction permits electrodes to be so rigidly mounted. Other features: Buell's advanced collecting electrode design . . . adjustable baffles. No wonder you're sure to be pleased with Buell's superior performance, minimum maintenance!

Buell Engineering Co., Inc., Department G, 123 William Street, New York 38, New York. Electric Precipitators · Cyclones · Bag Collectors · Combination Systems · Classifiers · Fans. Member Industrial Gas Cleaning Institute

buell Norblo

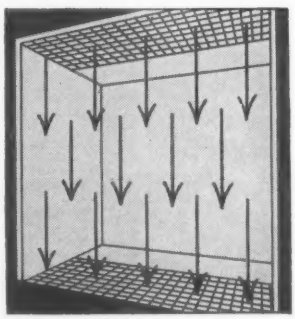
←[Circle #20 on page 35 reply cards]

[For more information circle #21 on page 35 reply cards]

the CLOSED door that's always OPEN

HOPPER PAPER COMPANY, TAYLORVILLE, ILLINOIS. Fire extinguisher fumes, simulating wind, are unable to penetrate the American Air Curtain Door.

A barrier to wind and weather, heat and cold, odors and insects — the gentle curtain of air seals off areas of different temperatures, atmospheric pressures or humidities. Dust and fumes from industrial operations are confined to their own areas, but even the heaviest traffic moves easily...safely. An American Air Curtain can mean increased efficiency in *your* plant. Let us show you how!



Air travels downward to form an invisible wall, creating a perfect seal between two areas.

AMERICAN AIR CURTAIN
A DIVISION OF UNIVERSAL MATCH CORPORATION
ST. LOUIS 35, MO. • NEW YORK 18, N. Y.

[For more information circle #22 on page 35 reply cards]

NEWS

White Rooms Make The Post

If your interested in White Rooms, you'll be interested in an article on this subject in the July 1, 1961 issue of the Saturday Evening Post, beginning on page 30, by Post writer Joe Alex Morris.

Way last year, Mr. Morris began his research for this article by interviewing, among others, the editor of AIR ENGINEERING, on White Rooms. We are happy to report that Mr. Morris was nice enough not only to give AIR ENGINEERING a plug in his fine story, but also mentioned the new white room association. Since seeing Mr. Morris, though, name of the association was changed from the name given in the Post article to the American Association For Contamination Control.

For more information about the AACC, just circle No. 200 on the postcard on page 35.

APCA Holds Annual Meeting

The 54th Annual Meeting of the Air Pollution Control Association was held recently in New York City, to the accompaniment of the usual dire warnings and alarums in the daily press on the subject of health aspects of air pollution.

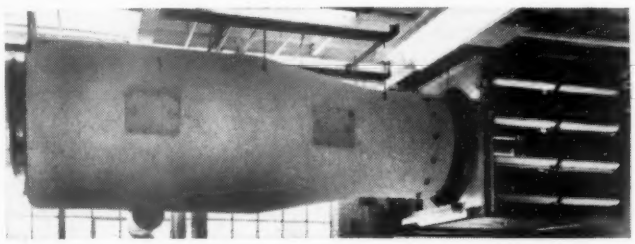
Attending the meeting were some 500 consulting engineers, specialists in pollution control, plant engineers, public relations people, public health and state and municipal air pollution control officials.

At a luncheon meeting those attending the meeting were addressed by Ivan A. Nestingen, Under Secretary of Health, Education and Welfare. Mr. Nestingen reviewed the growth of the industrial and technological revolution during the past 50 years, and noted that be-

(Please turn to page 18)

SUCCESS STORY

of a revolutionary air conditioning system!



CARRIER ROTASPRAY units require less than ⅓ the space of a conventional system of the same capacity—may be ceiling hung, wall cantilevered or mounted on the roof.

Six years ago Carrier pioneered an entirely new concept in air conditioning for industrial applications—the Rotaspray Weathermaker* System. It is now in operation in such widely different fields as textiles, plastics, rubber, candy, steel, cigar, paper, leather and garment. What is its record of performance? The best indication is the many repeat orders we've had . . . and are getting . . . from satisfied users. Can you use the Rotaspray System to advantage? Here are some of many reasons why it may be the best answer to new construction or reconversion problems.

UNITARY DESIGN. Instead of complete central station systems which require larger apparatus rooms, Rotaspray units are spotted conveniently throughout a plant. Only one central water handling apparatus is required.

FLEXIBLE INSTALLATION. Because of the compactness and low operating weight of Rotaspray units, they can be installed either ceiling hung, wall cantilevered or roof top mounted.

LOW MAINTENANCE. Rotaspray units incorporate self-cleaning "Cant-Clog" nozzles and a self-cleaning eliminator. Compared with large central station systems, they reduce cleaning and maintenance costs as much as 80%.

LONG LIFE. Rotaspray units are fabricated of stainless steel and other durable materials to assure years of virtually trouble-free operation.

HIGH EFFICIENCY AIR CLEANING. Each Rotaspray unit separates dust and other particles from the air . . . assures a "scrubbed clean" air supply at all times.

BETTER TEMPERATURE AND HUMIDITY CONTROL. By a new control method especially designed for the system, the old method of dew point control has been eliminated. Zoning control has also been eliminated. Each Rotaspray unit accurately controls temperature and humidity in its own area.

For complete information, write Carrier Air Conditioning Company, Syracuse 1, New York. In Canada: Carrier Air Conditioning Ltd., Toronto 14.

**Reg. U.S. Pat. Off.*

Carrier Air Conditioning Company

[For more information circle #23 on page 35 reply cards]

NEWS of the Industry . . .

(Continued from page 16)

cause of increasing population and burgeoning industry in vast citified complexes, the air pollution problem will be worse than it is now unless something is done about it soon.

He said that economic damage from air pollution is about $7.5-billion annually, while total local expenditure for control of air pollution amounts to only $8-million a year (exclusive of industrial expenditures, which amounts to about $350-million) and State outlays of only $1.5-million.

Mr. Nestingen said that his Department is working on a legislative proposal which would speed up air pollution control research and would also provide "more Federal assistance to States and localities in the development and support of control programs designed to apply the knowledge we now have." (See editorial on page 7.)

Legal Views: Attorney Frank L. Seamans, of the Pittsburgh law firm of Eckert, Seamans and Cherin, gave a paper on the legal aspects of air quality standards. He said that in view of the unavoidable mass of litigation that would ensue when air quality standards are finally set, it is to be hoped that these standards will be based on scientific evidence so as to be legally valid. At the present time there are no standards in universal use for outside air, except in California, unless colorimetric measures for such things as auto exhaust and stack emissions can be considered standards.

In a paper entitled "Prosecution Of Air Pollution Violations Under Common Law Nuisance," W. A. Quebedeaux, Jr., Houston, Texas, stated that the use of common law nuisance ordinances for air pollution abatement is the best procedure. Among his reasons: "Nuisance exists on basis of actual damage to person and property . . . common law nuisance has been honored with a long history and is in consonance with our democratic processes . . . is immediately available for the control officer to use . . . changing technology can produce overnight a new nuisance condition . . . abatement by common law may be obtained regardless of existence of a so-called air pollution control statute."

Pollution Control Techniques: A paper by Alfred Marzocchi, Frank Lachut and William H. Willis Jr., all of Owens-Corning Fiberglas Corp., reported on "Glass Fibers and Their Use As Filter Media." Paper discussed how glass fiber is made, converted and sewn into filter bags. Applications for glass fiber bags were given "for high temperature filtration in many major industries, such as carbon black, cement, steel, fertilizer, gray iron, gypsum, nonferrous metal and perlite." Efficiencies in these applications were reported as high as 99.96 percent.

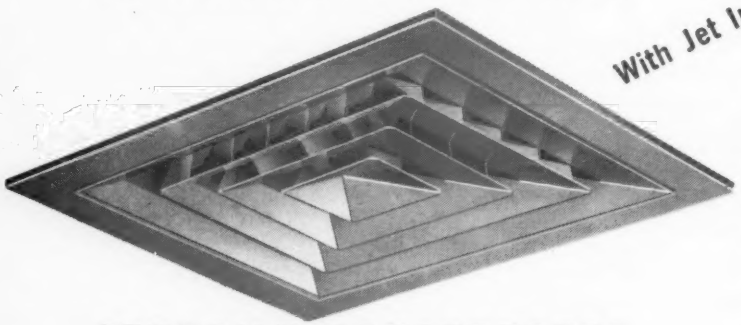
Another interesting baghouse

THE ORIGINAL SQUARE AND RECTANGULAR AIR DIFFUSERS

AGITAIR®

GENUINE PRODUCTS

With Jet Induction Diffusing Vanes



STURDILY CONSTRUCTED

- All louvers are firmly welded to diffusing vanes in parallel lines.
- The louvers cannot be tampered with or altered.
- Solid construction eliminates strumming or vibration.
- A metal plate is welded at the corner joints to add greater rigidity to the unit.

MORE THAN 1,000,000 IN USE TO-DAY

Only AGITAIR square and rectangular diffusers employ the jet induction feature due to scientically designed diffusing vanes.

These AGITAIR diffusers with built-in diffusing vanes, are designed and positioned to serve as air pumps, compressing the air into a multiplicity of jets. These jets issuing from spaces between adjacent louvers, produce a high degree of turbulence which rapidly mixes the primary and room air and assures control of the entire cubicle contents of the spaces served.

AGITAIR jet induction type diffusers are custom-made with louver arrangements for 1-2-3 or 4 way proportional blows.

Ask for technical catalog R-108

AIR DEVICES INC.

185 MADISON AVENUE, NEW YORK 16, N.Y.

BETTER PRODUCTS FOR

AIR DISTRIBUTION • AIR CLEANING • AIR EXHAUST

[For more information circle #24 on page 35 reply cards]

installation is described in detail by David L. Watts and James F. Higgins, both of Phelps Dodge Refining Corp. Baghouse at Laurel Hill Smelter works collects zinc oxides and other metallurgical gases. Bags are described as "fairly high porosity spun orlon without nap." Twin blowers handle 350,000 cfm at 232°F. through bags, which recover 700 tons of zinc oxide per month. Fumes from blast furnace, sinter plant, oil-fired settler, converter and the ventilation system are also cleansed in the baghouse.

Also on baghouses, a paper by G. W. Walsh and P. W. Spaite, both of the U.S.P.H.S., described research on bag shaking. Paper stated that "A well-defined limit will exist beyond which increased shaking with a given shaking stroke will not significantly contribute to further cleaning."

New Developments were described by Lauren B. Hitchcock, consultant. He stated that, among other results of air pollution: "In our more fully automated world of today, where machines themselves make and repair other machines, we discover that they are already becoming more delicate than man, and require atmospheres more highly purified than any provided for human beings. For example, telephone switching rooms, computers and information centers must be protected against the dirt and corrosion of our normal metropolitan atmosphere . . . cost of protecting such facilities is large and increasing."

"Disposal of refuse with due regard for air sanitation is leading to steadily mounting costs for more efficient incinerators, stack burners, dust collectors and other devices."

"Simple tracer techniques now make it possible to follow emissions from a given source for hundreds of miles."

Mr. Hitchcock described ultrasensitive instruments that could pick up emissions from the west coast by equipment located on the east coast. He said that: "Meteorologists have now developed techniques employing computers which" can be used to predict pollution concentrations at various elevations and distances. This permits "predictions of maximum concen-

(Please turn to page 44)

Send for FREE Data Book

LET **BURT**

MAKE AIR WORK FOR YOU

391 Standard Models To Choose From
PLUS Complete Facilities To Design
And Manufacture Special Ventilators

BURT VENTILATOR	TYPE	CAPACITY (CFM)	SIZES	MODELS	DISCHARGE
FREE-FLOW GRAVITY	Gravity	113 to 35,560	16	16	Upward
LO-HYT GRAVITY	Gravity	AS REQUIRED	18	18	Downward
MONITOR	Gravity	MADE TO ORDER		1	Upward
MONOVENT (Ridge)	Gravity	48 to 5,184	15	15	Upward
REVOLVING	Gravity	123 to 10,931	17	17	Sideward
STANDARD GRAVITY	Gravity	35 to 24,890	19	19	Upward
THERMAVENT	Gravity	MADE TO ORDER		2	Upward
CENTRIFLOW	Power	65 to 36,430	56	184	Downward
FREE EXHAUST FAN	Power	5,000 to 75,550	7	17	Upward
FREE FLOW FAN	Power	1,040 to 99,050	15	35	Upward
LOW TYPE	Power	337 to 47,400	15	60	Downward
STANDARD FAN	Power	685 to 15,000	10	10	Upward

There is a type of Burt Ventilator to meet any ventilating problem that Roof Ventilators can solve. Burt's specialized engineering, equipment and craftsmanship—from 60 years of designing and building ventilators—is your assurance of complete satisfaction. Cost economies are assured from almost 400 *standard* models that are quickly available. Write for Burt's Complete Line Data Book—it's free!

VENTILATORS • LOUVERS • SHEET METAL SPECIALTIES

The Burt Manufacturing Company

942 S. High Street — Akron 11, Ohio

MEMBER AIR MOVING & CONDITIONING ASSOCIATION, INC.

[For more information circle #25 on page 35]

How To Reduce Building Costs By Combining Radiant Air System With New Cellular Air Floor

Sizeable savings in building space, volume, first and operating costs can be obtained by utilizing available energy sources within the building in a radiant air system which uses a cellular air floor distribution.

by **Gershon Meckler**, *P.E., Meckler Engineering Co., Toledo, Ohio*
John S. Hickman, *Engineered Products Div., Inland Steel Products Co., Milwaukee, Wis.*
Milton Meckler, *P.E., Meckler Engineering Co.**

FROM PART (1) of this series on building integration (AIR ENGINEERING, Feb., 1961), Dynamic Integration was defined as the combining of "two or more building systems, permitting direct interaction of system energies in such a way as to increase the efficiency and/or reduce the net energy requirements of the integrated building systems." In this article we shall introduce a new air conditioning system: The Radiant Air System, which permits marriage of the total environment with building structure.

The Radiant Air System utilizes Dynamic Integration to provide the following benefits:

- **Direct savings in building volume.**
- **Direct savings in combined cost of the electrical and mechanical distribution systems which become integral with one another.**
- **Reduced air circulation rates.**
- **Lower fan and refrigeration horsepower requirements.**
- **Temperature staging to permit higher refrigeration Coefficient of Performance.**
- **Economical heat pump operation in northern climates.**

Additional benefits that result from the use of the Radiant Air System include:

- **Complete flexibility for future changes in building environment, temperature, lighting and acoustical control, etc.**
- **Independent temperature and humidity control.**
- **Simplified low pressure air distribution system.**
- **Simplified piping and controls.**

Facilities design, whether it be for an office building, laboratory, or hospital, requires intelligent development and utilization of design concepts and techniques which permit each system to become a functional part of all others.

For optimum comfort conditions, separate and independent control of humidity and sensible cooling must be achieved and sensible heat removal should be accomplished by both radiation and convection. The Radiant Air System is arranged to utilize radiant heat transfer, convection heat transfer and latent heat removal in proper combination with the heat storage characteristics of the building. The Radiant Air System also permits the use of cellular steel deck for both supply and return air and provides a practical design technique for the integration of the total environment with the building structure.

*Gershon Meckler is a member of the Illuminating Engineering Society Technical Committee on lighting and air conditioning, owner of Meckler Engineering Company, Consulting Engineers, a graduate of Pennsylvania State University and a registered professional engineer in Ohio, Indiana, Michigan, W. Va., and Pa. Mr. Hickman is a project engineer, Engineered Products Division, Inland Steel Products Co., a graduate of the University of Wisconsin, past chairman, Technical Committee of the Metal Roof Decks Technical Institute and representative, ASA Sectional Committee, Portland Cement Association. Milton Meckler is an Associate of Meckler Engineering Co., a graduate of Worcester Polytechnic Institute and the University of Michigan and a registered professional engineer in Ohio and Michigan.

The Integrated Radiant Air System is a split system and removes the air conditioning load by means of radiant cooling, convection cooling and chemical de-humidification. Chemical de-humidification is effective in destroying bacteria and removing airborne microorganisms.

The Radiant Luminous Ceiling as illustrated in Fig. 1 is arranged with an upper radiant ceiling panel integrated with the lighting fixtures and the lower "louvered" radiant ceiling arranged to view both lighting and space load. In the building interior, conditioned air is supplied by means of diffusers arranged in the upper ceiling, and returned by means of return air registers located in the upper ceiling. The "louvered" radiant ceiling system removes lighting heat load as well as space load. In addition, it serves as an efficient light diffuser controlling brightness. The electrical input to the lighting system required to produce a given illumination varies with the ceiling cavity dimensions, surface reflectances, the type of lamp and ballast used and the reflective and/or absorptive character of the lighting diffuser.

The lower ceiling panel consists of an arrangement of water cooled supporting tees and a heat transmitting light diffusing panel. The tees are arranged on a modular basis to provide a maximum flexibility for future space changes, as well as temperature control changes. *Each individual space module can have its own independent temperature control.*

Temperature control zones are set up by perimeter exposure orientations with areas under individual control. The exterior sections of the perimeter zones are controlled on the basis of solar heat gains and the outside air temperature. The interior areas are controlled by means of a space thermostat. The lower light diffusing ceiling panel provides temperature control of the occupied space. The Radiant Air System is designed to provide maximum flexibility and to discriminate between the type of load occurring at the perimeter and at the interior of the building. The perimeter "Radiation Barrier" consists of a vertical wall panel running from column to column at the perimeter and a perimeter soffit panel at the ceiling running along the exposed perimeter. These panels are arranged to provide a "Radiation Barrier" at the exposed wall.

Fresh de-humidifier air is introduced to the occupied spaces to provide ventilation and to remove latent heat. A minimum amount of outside air is filtered and de-humidified by means of chemical de-humidifiers which bring air into contact with a hygroscopic solution. This solution removes or adds moisture in selected amounts. All required de-humidification for removal of space latent heat is provided by the chemical de-humidifiers. Outside air introduced for ventilation purposes is de-humidified to a lower than conventional absolute humidity level and then is mixed with re-circulated air from the space to provide proper space latent heat control. The total mixed air is then sensibly cooled to a discharge temperature of approximately 63°F to 65° at the proper absolute humidity level. The total air is then distributed by means of unzoned vertical ducts located in shafts at the core of the building.

At the ceiling of each floor, horizontal header ducts extend from the vertical shaft ducts and distribute air to the cellular steel air floor. The cells in the floor act as branch ducts which distribute air through the floor to diffusers serving the occupied space. The supply air temperature to the space is fixed and does not vary as a function of the space load. A common return air system serves both the

(Please turn to following page)

ESTIMATED LOAD REMOVAL CAPACITY

NOMINAL F.C.	CFM. PER SQ FT AIR	LOWER PANEL TEMP.(°F)	UPPER PANEL TEMP.(°F)	THERMAL LOAD DISTRIBUTION		
				% ON AIR	% ON UPPER PANEL	% ON LOWER PANEL
100	0.6	68	71	18	43	39
150	0.6	67	71	20	46	34
200	0.6	65	71	20	50	30
250	0.9	65	71	22	53	25
400	1.5	65	71	26	54	20

NOTE ABOVE TABLE IS PREPARED FOR TYPICAL OFFICE BUILDING OCCUPANCY LOAD AT THE DESIGNATED LIGHTING LEVELS

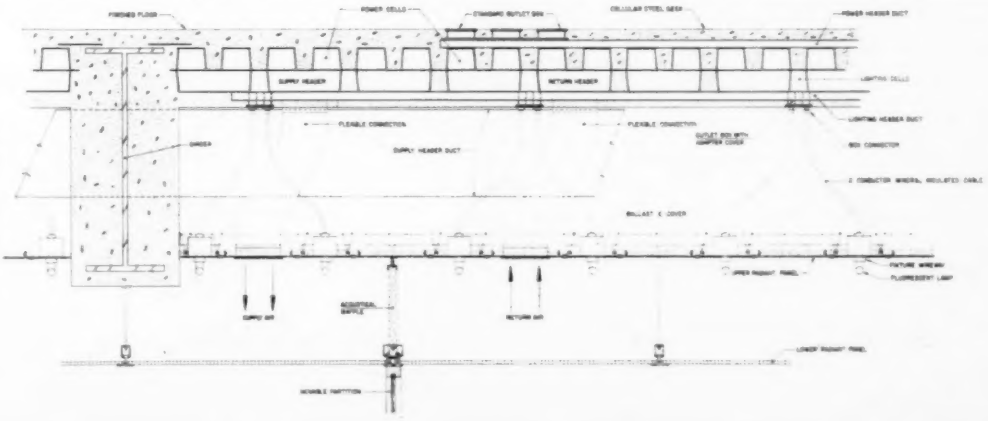


Fig. 1: Integrated louvered ceiling and cellular floor arrangement. Table at upper right, above drawing, gives system design factors.

(Continued from preceding page)

perimeter and interior of the building. It consists of a vertical return air shaft at the core of each floor extending to the main equipment floor, where a portion of the air is exhausted and the balance returned to all the air handling system.

At the peripheral areas of the building, where more than 75 percent of floor to ceiling exterior curtain wall consists of glass, air is introduced at the interior of each space and is directed toward the curtain wall. The perimeter return air grilles are located on the ceiling and on the floor between the exterior curtain wall and the venetian blind.

Fig. 2 and Fig. 2A illustrate the use of a Radiant Barrier system for a 100 percent floor to ceiling glass exterior curtain wall. The solar energy enters the glass curtain wall on the venetian blind surface except for an amount that enters the space directly. All space air is returned at the window through ceiling and floor return air registers. It is possible to maintain a higher surface temperature on the inside surface of the glass curtain wall and use return air to remove some heat by conduction-convection. The venetian blind acts as an intermediate surface between the glass curtain wall and the perimeter "Radiation Barrier" panels. The perimeter panels view the entire blind surface and exchange heat directly by radiation from the venetian blind.

In this system, the amount of air circulated is significantly reduced since:

1. **Space air is allowed to return at relatively high temperatures.**
2. **The "Radiation Barrier" panels remove a significant amount of heat by radiant interchange with the venetian blind.**
3. **A portion of the solar heat is removed directly by radiation to the "Radiation Barrier" panels.**

Estimated load removal capacity:

A. Radiation Barrier Panels:
20 percent of maximum instantaneous solar space gains.

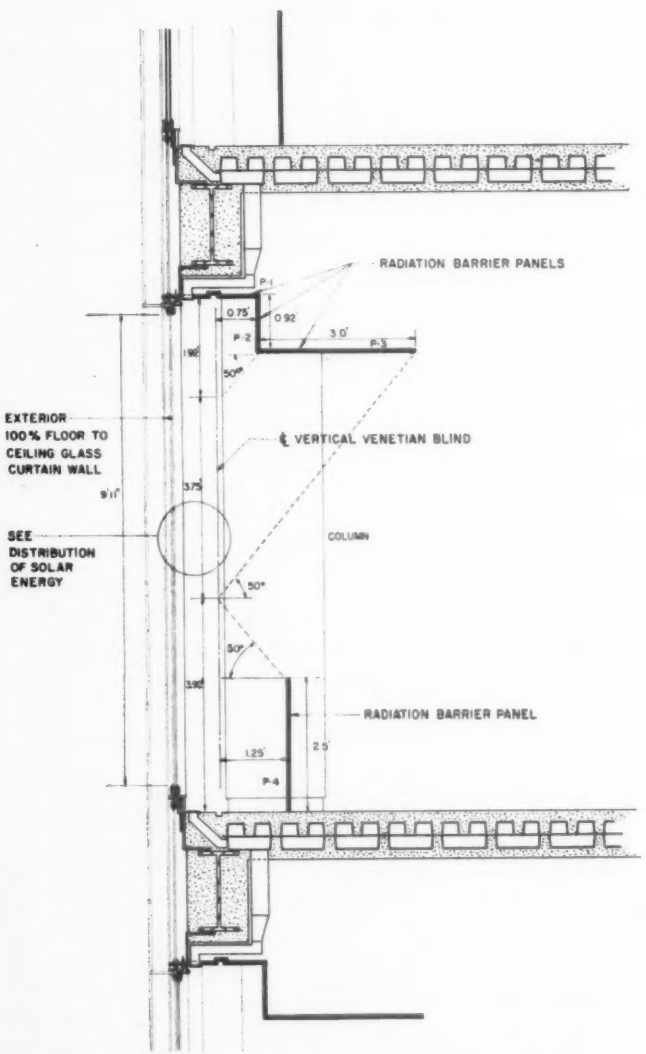
B. Perimeter return air system:
55 percent maximum instantaneous solar space gains.

Both the perimeter return air and interior return air are connected to the cellular steel floor which returns the air to a common return air header which is connected to the vertical return air shafts at the core of the building.

Temperature Staging

Temperature staging is a unique feature of the Radiant Air System which permits increasing refrigeration efficiency by removing load at successively higher temperature levels.

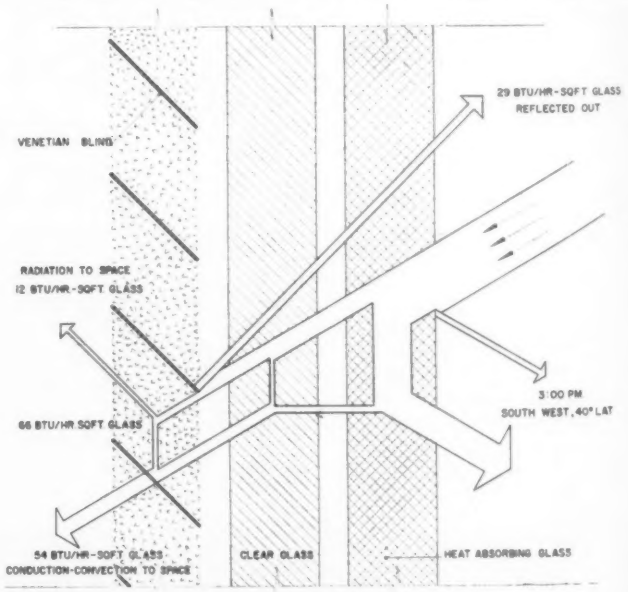
Temperature staging is utilized primarily on the chilled water circuits sequencing flow through the air handling units, Radiant Luminous Ceiling, Radia-



RADIANT BARRIER SYSTEM

Fig. 2: Drawing above illustrates use of a radiant barrier system for a 100-percent floor-to-ceiling glass exterior curtain wall.

Fig. 2A: This is an enlarged section on the circled portion on Fig. 2, showing distribution of solar energy in the system.



DISTRIBUTION OF SOLAR ENERGY

tion Barrier System, and the chemical air conditioner as required. Refer to Fig. 3 for the general arrangement and sequence of water distribution circuits, described below.

Circuit No. 1 is a series flow arrangement in which chilled water from a refrigeration machine flows first to zone air handling cooling coils taking approximately an 8-10°F rise in water temperature. From this total quantity, an amount capable of giving a 5°F rise in water temperature is supplied to lower radiant ceiling panels. A temperature gradient of 5°F is provided between average panel temperature and mean circulated water temperature to overcome panel conduction heat flow resistance. The panel water quantity is determined on basis of 5°F rise through each ceiling panel. In this way a 13-15° rise in total water circulated is achieved with chilled water supply at or near 50°F.

Circuit No. 2 is a series flow arrangement in which chilled water from a refrigeration machine flows first to perimeter Radiant Barrier panels covering each exterior wall on every orientation providing a 65°F average panel surface temperature. A 2°F temperature gradient is provided between average Radiant Barrier panel temperature and mean circulated water temperature to overcome panel conduction heat flow resistance.

Radiant Barrier panel return water flows to upper radiant ceiling, rising approximately 10°F under design load. A temperature gradient of 3°F is provided between average upper radiant ceiling panel temperature and mean circulated water temperature to overcome panel conduction heat flow resistance. In this way a 15° rise in total water circulated is achieved with a chilled water supply from 60-61°F.

The Radiant Air System being an "air-water" system can effectively utilize available heat generated by the lighting system to help provide the heating requirements during cold weather. The Radiant Air System is arranged to heat pump and transfer the light heat gains from the Integrated Radiant Ceiling (Lower Radiant Ceiling and Upper Radiant Ceiling) panels to the air preheat coils in the air handling systems. The economies of the heat pump cycle are extremely significant, in view of utilization of available lighting heat.

With the requirement for simultaneous heating and cooling in different parts of the same building, it is advantageous to use the heat rejection from the refrigeration condenser provided the level of the heat source is usable. For every 12,000 Btuh removed by the refrigeration chiller, approximately 15,000 is available at the condenser. By resetting the condenser leaving water temperature to approximately 120°F, energy becomes available for tempering ventilation air as well as heating perimeter occupancy zones.

The building products utilized as components of the Radiant Air System are primarily architectural products. The significant consequence of building integration is the *most complete utilization of architectural building products.* The Radiant Air System permits the architectural products to serve a dual purpose; architectural and structural building products become available for use as components of the mechanical and electrical systems. For example, the lower "louvered" ceiling serves as a lighting diffuser, a radiant ceiling and a finished architectural ceiling. Similarly, the cellular floor serves as a structural sub-

(Please turn to page 41)

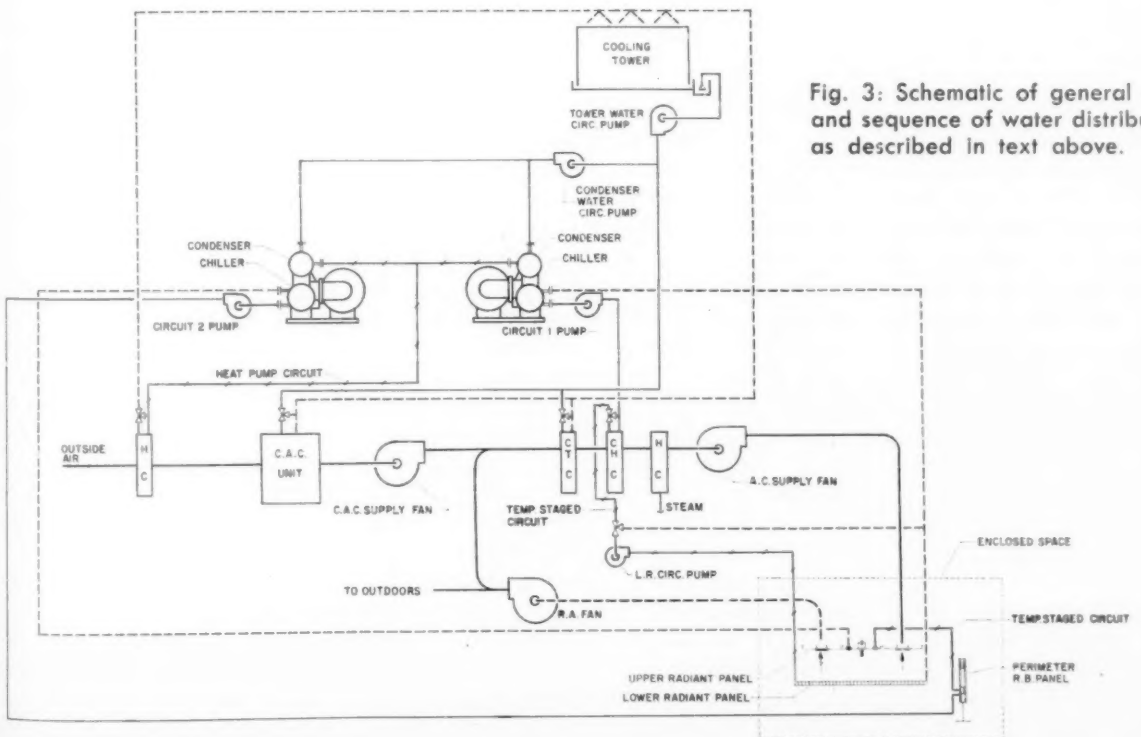


Fig. 3: Schematic of general arrangement and sequence of water distribution circuits, as described in text above.

Industrial Heat Exposure And Control

It's summer and h-o-t in factories, so heat from processes and just plain solar gain can raise havoc with production. Here are some practical ways to reduce heat exposure and cool off workers in your plant.

by Robert C. Lemke
Industrial Hygiene Engineer, Michigan Dept. of Health

Mr. Lemke is a graduate mechanical engineer and a member of the American Conference of Governmental Industrial Hygienists.

Part I

Above: Raw, outdoor air is introduced to spot cool workers knocking sprues off hot castings at Auto Specialties plant, St. Joseph, Mich.

HUMANS MUST maintain a body temperature of about 98.6°F. This body temperature is kept constant because heat produced by metabolism and heat absorbed from the environment is given off through radiation, convection, or sweating (evaporation). In extreme conditions of heat, the body is unable to give off excess heat so fatigue, loss of efficiency, and sometimes physical collapse results.

In late years there has been an increasing trend to provide measures for reducing industrial heat to prevent stress conditions, and also to provide a more comfortable working environment. Industry is finding that comfortable employees produce more efficiently because fatigue, absenteeism, and accidents are reduced. Office workers have long enjoyed the benefits of air-conditioning. As long ago as 1956, an *Iron Age* survey reported that 62 percent of all metal working plants had air conditioned offices. More and more, industries where a high degree of skill and concentration is required have found that reducing heat increases efficiency. When an industrial heat problem exists, a knowledge of the contributing factors is necessary if an effective, economical solution is to be found.

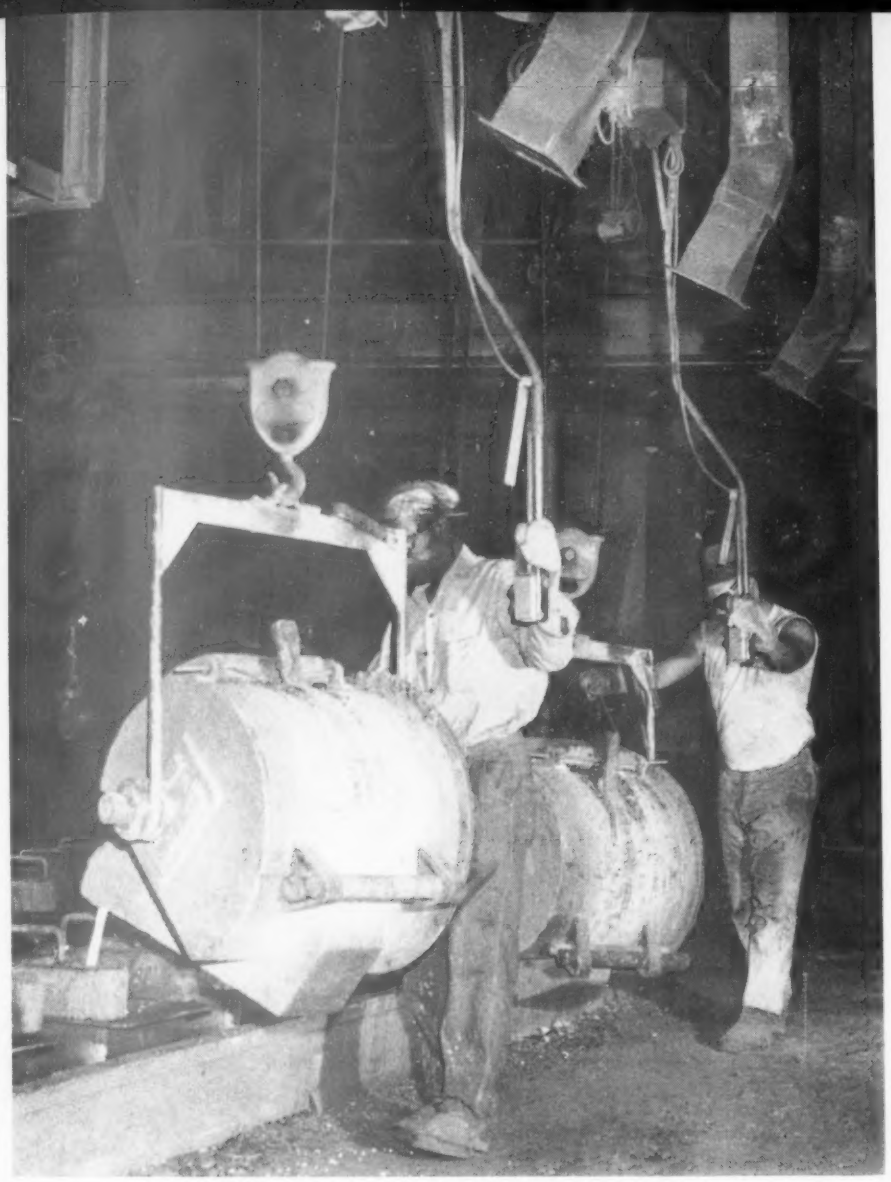
Body heat comes primarily from within. Heat is produced in amounts varying with the amount of physical activity. Table 1 shows that the production of metabolic heat varies from 250 Btu per hour during sleep, up to 2400 Btu per hour for hard sustained work.

The bulk of this deep body heat is carried to the skin by blood where it is dissipated into the atmosphere by radiation—releasing heat energy in the form of heat waves; by convection—releasing heat that's carried away by air currents; and evaporation—releasing heat by vaporizing sweat. In environments where we feel comfortable, about 60 percent of the body heat is lost by radiation.

If a worker is exposed to high radiant heat, from, say a furnace, and to additional convective heat from warm or hot air, the major method left for his body to give off heat is evaporation of perspiration produced by the sweat glands. Evaporation, however, is limited by such measurable factors as air velocity, humidity and temperature, and by the type of clothing worn and the water content of the body. All these must be taken into consideration when evaluating possible heat stress in the workplace.

The water and salt lost through perspiration must be replaced. As much as 12 quarts of water can be lost through perspiration in an eight hour day, but thirst, the expressed need for water, lags behind the actual need for replacement water. Because of this, workers need to be encouraged to drink water at frequent intervals.

The salt loss can best be made up by using abundant salt at meals. Salt tablets, once considered necessary, are not generally recommended any more. Workers, who for medical reasons are on a salt reduced diet, should not be given jobs where they are likely to be overheated.



Left: Raw, outdoor air introduced at grille face velocity of 800 cfm spot cools metal pourers in malleable iron foundry of Auto Specialties plant, St. Joseph, Mich.

Because accumulated body heat may take time to dissipate, rest in a cool atmosphere is a logical and practical way of reducing body heat, or cooling off. Air conditioned rest stations have been provided in some industries where it is impractical to cool the work station. Workers subject to heat stress spend scheduled periods of time in these cooling-off rooms.

A variety of industrial processes can produce heat problems. For example, a particular heat problem was found in a plating shop. This heat problem was not created by the heat from the tanks alone, but also by the high moisture content of the air which limits the workers' ability to cool themselves through evaporation of perspiration. This problem was easily resolved by exhausting the process-produced moisture directly to the outside and replacing the exhausted air with drier outside air.

Heat problems can be found in areas where no heat is ostensibly produced. An office, located directly over a laboratory glassware washing and sterilizing units, was completely unsuited for any kind of mental effort. Heat from the washing room, plus process steam pipes located in the floor of the office, resulted in temperatures over 95°F during summer months. Radiant heat from the floor also kept workers over-heated. The conditions resulted in heat fatigue and severely lowered the efficiency of the office staff, just as heat lowered efficiency of the industrial workers in the previous example.

Another radiant heat problem common to foundry operations is described for use in the sample calculation section for evaluating heat stress.

The primary purpose for evaluating a suspected heat condition is to predict the effect of heat on the worker. Since the evaluation process involves physical measurements for wet bulb and dry bulb temperatures, globe temperature and air velocity to determine the effect of radiant heat, convective heat and evaporative capacity, a

(Please turn to following page)

		M Btu/hr
	Sleeping	250
	Sitting Quietly	400
Light Work	Sitting, moderate arm and trunk movements (e.g., desk work, typing)	450-500
	Sitting, moderate arm and leg movements (e.g., playing organ, driving car in traffic)	550-600
	Standing, light work at machine or bench, mostly arms	550-650
Moderate Work	Sitting, heavy arm and leg movements	650-800
	Standing, light work at machine or bench, some walking about	650-750
	Standing, moderate work at machine or bench, some walking about	750-1000
	Walking about, with moderate lifting or pushing	1000-1400
Heavy Work	Intermittent heavy lifting, pushing or pulling (e.g., pick and shovel work)	1500-2000
	Hardest sustained work	2000-2400

Table I: Estimates of energy metabolism (M) of various types of activity. (Values apply for a 154 lb man, do not include rest pauses.) From ASHAE Journal section of Heating, Piping and Air Conditioning, Aug. 1955.

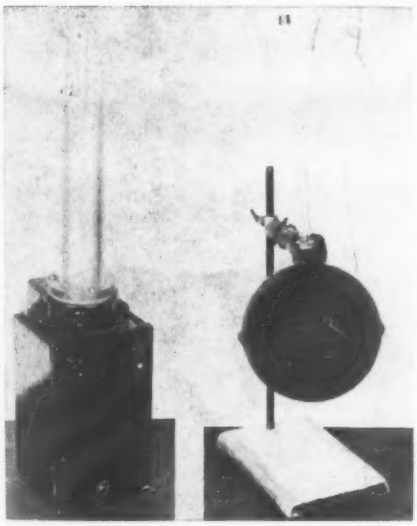
(Continued from preceding page)
secondary purpose is also served. The physical measurements and subsequent calculations tend to present a clear picture of the plant conditions contributing to the heat problem and point out the most logical and effective control measures that can be taken to reduce the condition.

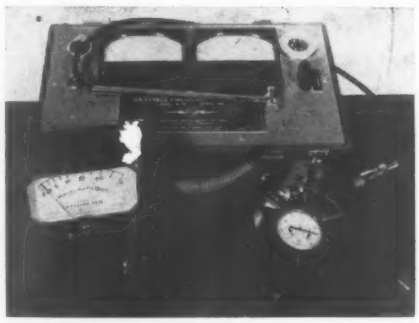
Equipment and Measurements

Wet and dry bulb temperature readings can be taken with a sling psychrometer. To prevent the possibility of radiant heat waves, which travel in straight lines and are unaffected by air motion from affecting the air temperature readings, the thermometer bulbs must be shielded when used in sources of radiant heat. This shielding is most easily accomplished by inserting the psychrometer into a short section of aluminum tubing and drawing room air through the tubing with a blower arrangement.

Globe temperature readings are used for determining the mean radiant temperature required for radiant heat calculation. A standard six-inch toilet float ball can be used to construct a globe thermometer. It should be painted a flat black both inside and outside, and the thermometer bulb inserted to the center of the globe. In theory the globe or black ball thermometer will absorb all of the incident radiant heat waves that strike it.

Air velocities are best obtained with an air meter (an electrical device for measuring low air velocities). However, this is an expensive piece of equipment that many plants may not have available or be able to obtain. Since low velocity measurements are not as critical to the calculations as are the temperature readings, simpler devices such as a velometer or anemometer may be used.





Above left: Sling psychrometer in shield. Right, globe thermometer. Below: Air velocity measuring instruments. Top, air meter; left, an anemometer; bottom right, a velometer.

Method of Evaluation

One method of evaluating a heat condition is by comparing the required amount of evaporative heat loss needed by the worker to maintain a body heat balance (E_{req}) with the maximum amount of heat loss that the worker can achieve in his industrial environment (E_{max}). This comparison of the maximum and required evaporation rates is the basis for the Belding, Haines and Hatch *Heat Stress Index* (HSI) which states: *"If the required amount of evaporative heat loss needed by the body is greater than the maximum amount of heat loss that can be achieved, body heat balance cannot be maintained and heat stress conditions will result."*

The heat balance equation relates body heat input to body heat output. The primary source of heat imposed on our system comes from within. It is the heat generated as a result of muscular action and the converting of food to heat energy. Internal heat is referred to as a metabolic heat (M) and is always adding to the body heat load in amounts varying with the amount of work being done as indicated on Table 1. Since metabolic heat is the heat produced by the body, it is always positive in the heat balance equation.

When heat from radiation and convection is adding to the overall body heat load, it is also positive. However, the body may be dissipating heat by either of these two modes of transfer and they then become negative values in the heat balance equation.

The remaining variable in the heat balance equation is the heat

(Please turn to page 42)

Index of Heat Stress	Physiological and Hygienic Implications of 8-hr. Exposures to Various Heat Stresses
—20 —10	Mild cold strain. This condition frequently exists in areas where men recover from exposure to heat.
0	No thermal strain.
+10 20 30	Mild to moderate heat strain. Where a job involves higher intellectual functions, dexterity, or alertness, subtle to substantial decrements in performance may be expected. In performance of heavy physical work, little decrement expected unless ability of individuals to perform such work under no thermal stress is marginal.
40 50 60	Severe heat strain, involving a threat to health unless men are physically fit. Break-in period required for men not previously acclimatized. Some decrement in performance of physical work is to be expected. Medical selection of personnel desirable because these conditions are unsuitable for those with cardiovascular or respiratory impairment or with chronic dermatitis. These working conditions are also unsuitable for activities requiring sustained mental effort.
70 80 90	Very severe heat strain. Only a small percentage of the population may be expected to qualify for this work. Personnel should be selected (a) by medical examination, and (b) by trial on the job (after acclimatization). Special measures are needed to assure adequate water and salt intake. Amelioration of working conditions by any feasible means is highly desirable, and may be expected to decrease the health hazard while increasing efficiency on the job. Slight "indisposition" which in most jobs would be insufficient to affect performance may render workers unfit for this exposure.
100	The maximum strain tolerated daily by fit, acclimatized young men.

Table II: Index of heat stress. From "Index For Evaluating Heat Stress In Terms of Resulting Physiological Strains," H. S. Belding, T. F. Hatch, ASHAE Journal Section of Heating, Piping and Air Conditioning, Aug., 1955.

Applications of Wet Scrubbers In Industrial Gas Cleaning

Describes types of scrubbers, best applications, performance tests on Doyle type. For dryers, roasters, fine dusts, and mists.

by Gordon T. Nicklin
Chemical Engineer
Western Precipitation, Div. of Joy Mfg. Co.

A SCRUBBER MAY BE considered in its simplest form as a rain tower in which water droplets merely fall by gravity through a gas. This type of scrubber is not considered effective as a gas cleaning device where removal of finely divided dust and fume particles is desired.

From this simplest form of rain tower, improvements in scrubbing are accomplished by the use of baffles and other restrictions, to provide a tortuous path for the dust and gas. Such arrangements are the centrifugal types, impingement types, packed towers, film towers, wet filters, scrubbers with rotating elements, the venturi and the Doyle together with series or tandem collection systems.

The following group classifications describe some commercial scrubbers and their general operating characteristics:

Washer and Spray Chamber Type: This first classification relates to such types of washers, manufactured by numerous concerns, as air-conditioners, humidifiers, and spray chambers (with or without baffles and louvers) utilizing spray nozzles, which may be arranged con-current or counter-current to the gas flow.

These scrubbers generally are designed for medium to high pressure vessels. They normally utilize low to medium pressure drop or power requirements. Also, gaseous through-put velocities are usually low, in the order of five ft. per second or less. Water requirements approximate 2 gpm/1000 cfm of gas treated.

This general classification also includes the water-jet ejector type which utilizes a water-jet spray through a venturi orifice with water rates of 50 to 100 gpm/1000 cfm of gas. This method generates the required suction or draft necessary for the gas-handling requirement.

Centrifugal Scrubbers: Included in this classification are units known to industry as the Pease-Anthony cyclonic scrubber, the centrifugal washer, the fog filter, the hydroclone, the rotoclone, and the multiwash types.

Centrifugal scrubbers are generally designed for low operating pressures of not more than one to two psig. Pressure drop or power requirements are correspondingly low, in the range of 2 to 5 in. w.g. The gas capacity of this type is up to approximately 200,000 cfm.

This type is particularly adaptable to the use of high pressure sprays if increased efficiency is required. General water requirements vary from 3 to 30 gpm/1000 cfm gas treated.

Another application of the centrifugal scrubbers is that they may act as mist eliminators for final clean-up from the venturi and similar types of impingement separators.

Venturi Scrubbers: The paper mill, steel and chemical industries are familiar with the venturi types, including the multiple-action venturi impingement units, as manufactured by several companies. Generally, design pressures range less than 2 to 5 psig, but in some cases may be as high as 15 psig. Operating power requirements can vary from a normal of 8 in. w.g. up to as high as 40 in. w.g. pressure drop and utilizing water sprays of 2 to 3 gpm/1000 cfm up to 20 gpm/1000 cfm of gas treated. Normal design gas volume capacities range from approximately 2,000 cfm to about 50,000 cfm per unit.

The venturi type of scrubber usually employs high gas velocities in the range of 100 to as much as 500 fps at the venturi throat. In addition, high pressure water sprays can be introduced into the throat annulus for the purpose of creating finely divided mist, but with very high throat velocities high pressure sprays are not necessary. This method creates extreme turbulence and aids in wetting finely divided dust and fume particles by intimate contact of the gases and water mist formed.

Impingement Types: The impinge-

(Please turn to following page)

(Continued from preceding page)

ment plate, impingement baffle, disintegrating nozzle type, and the knitted metal mesh types of scrubbers comprise this catagory.

Included in this group is the Doyle impingement scrubber as developed by the Consolidated Mining and Smelting Company of Canada which utilizes high velocity impingement directly into a water bath. This scrubber is described later.

The design pressures of impingement type scrubbers can range from a high vacuum to a high pressure depending upon process requirements. The gas volume capacity can vary from about 100 cfm to 100,000 cfm or more, utilizing velocities from 5 to 30 fps for the general classification. The exception is the Doyle scrubber, which utilizes impingement velocities ranging from 100 fps to 250 fps or more depending upon the type of application and materials being treated.

Wet Filters: This type of scrubber utilizes a glass or other fiber filter over which water is sprayed. Standard and custom-made units employ scrubber media of various densities of woven cloth or knitted metal filters. The thickness of these interwoven metal mesh elements can vary from one to four inches depending upon filter requirements.

Wet filters are usually designed for essentially atmospheric pressures, normally handle gases containing low dust concentrations and operate with fairly low velocities in order to prevent mist re-entrainment. These types of filters are used in the air conditioning, both domestic and industrial, and are considered fairly good mist eliminators.

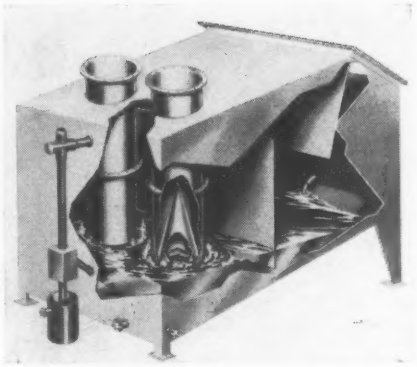


Fig. 1: Doyle scrubber. Inlets are at top left, outlet at top right.

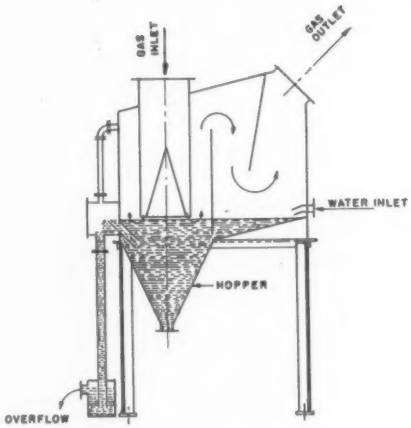


Fig. 2: Flow of materials through hopper type Doyle scrubber is shown above.

Packed Towers: The application of packed towers in the chemical industry is well known. This class of scrubber employs hollow cylinders, raschig rings, saddles, etc., packed one upon the other in a regular staggered manner, or in a random fashion, to give intimate contact between gas being treated and the liquid contact media. Generally, gases pass counter-flow to the liquid being fed over the packed tower medium. Water requirements range from 10 to 50 gpm/1000 cfm and gas velocities are necessarily low at about 3 fps.

Film Type Towers: These units are usually custom-made by various manufacturers, generally circular in design and simple in construction. A liquid film flows down the side and over vertical baffles or fins with very close spacings. For this type of tower, gas velocities are even lower than those previously mentioned and are in the range of 1 to 3 fps. This type of equipment is generally used for absorption, chemical conversion, or neutralization of gases, vapors, etc.

Rotating Elements: This last classification of scrubbers includes such types as the baffled unit equipped with a spray rotor, the Theisen disintegrator, and the centrifugal rotor scrubber. The Theisen type unit is one of the high power consumers and is rated at about 10 hp/1000 cfm. The steel and chemical industries have used these types as washers, conditioners, or for decreasing dust loads in process gases.

Most water scrubbers are used by industry for removal of dust and fume of a particulate nature from a gas stream. We are confining our discussions primarily to the use of water as the scrubbing and cooling medium, and to the

IMPINGEMENT SCRUBBER INDUSTRIAL APPLICATIONS

Paper Plants
1. **Precipitated Lime Dust and Fume Recovery**
2. **Salt Cake Fume Recovery**
3. **Smelt Dissolving Tank Vent Systems**

Coal Processing
1. **Dryers and Ventilation Clean-up**
2. **Pulverizers, Coal, Fume, Fired Boilers**
3. **Fly Ash Treatment**

Steel Industry
1. **Sinter Plant Discharge Vent Systems**
2. **Ore Processing and Ventilation Systems**
3. **Coal Processing Clean-up Systems**

Combustion Processes
1. **Dryers**
2. **Sinter Plant Vent Systems**
3. **Roasters**
4. **Reverberatory Furnaces**
5. **Secondary Lead Blast Furnace and Reverberatory Melting Furnace**

Rock Product Processing
1. **Crushers**
2. **Dryers**
3. **Kilns**
4. **Vent Systems:**
   - **(a) Storage Bins**
   - **(b) Elevators**
   - **(c) Transfer Points**

Phosphate Plants
1. **Phosphate Rock Dryers**
2. **Acidulation Operations**
3. **Agitator Vent Gases**
4. **Acid Filter Gases**
5. **Fertilizer Processing Dryers and Kilns**

Chemical Industry
1. **Phosphoric Acid Mist**
2. **Reaction Vessels**
3. **Aluminum Plants**
4. **Metallurgical Processes**

consideration of dust and fume removal.

Generally speaking, the total power input, including the proper water requirement to a scrubber system, has a direct relationship to the collection efficiency. The power induced to produce the overall scrubber pressure drop, whether it be gas velocity power, high pressure spray power, or combinations of both, is related to the N.T.U. (the Number of Transfer Units, a measure of the difficulty of separation) as a measure of this power required to effectively scrub the particles and efficiently remove them from the gas stream.

A scrubber operating with a pressure drop of 2 to 3 in. w.g. may collect only 70 percent of the material in the particle size range of 2 to 5 microns; whereas, scrubber systems operating at pressure drops of up to 30 in. w.g. or more, such as with the venturi, Doyle, orifice, or other medium to high velocity impingement type units, may have collection efficiencies as high as 98 percent to 99 percent for this same material. Normally, a scrubber of the centrifugal or baffle type, utilizing pressure drops in the 4 to 5 in. range, will have their collection efficiencies limited to about 85 percent to 95 percent with an average particle size limitation of not less than 5 microns. The higher pressure drop scrubbers can handle dusts and fumes in the fineness range down to about 0.5 to one micron size.

Gas Temperature

The effect of gas temperature is an important consideration when fairly high collection efficiencies are desired. When the gas temperature is fairly high, say in the order of 500°F and above, considerable benefit may be obtained by means of so-called "shock cooling." This phenomenon is particularly beneficial when relatively large amounts of water are available in the cooling and scrubbing process. In a scrubber of the multiple-pass type, after the initial gas is cooled to saturation conditions, added water produces condensation. This condensation benefit creates films of water around the dust and fume particles which aid in removing them from the gas stream. Similarly, subsequent treatment, such as creating a centrifugal whirl to the gas, further aids this dust and water particle removal.

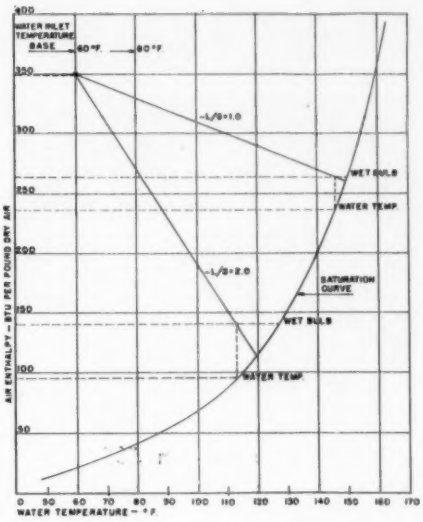


Fig. 3: Water rates are often determined by enthalpy change required for pre-determined outlet operating conditions, as shown above.

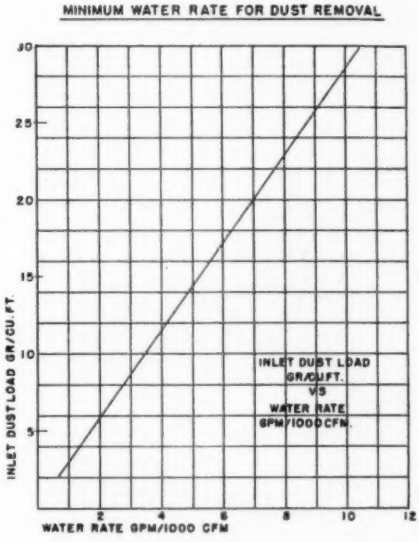

MINIMUM WATER RATE FOR DUST REMOVAL
INLET DUST LOAD GR/CU.FT. VS WATER RATE GPM/1000 CFM.
INLET DUSTLOAD GR/CU. FT.
WATER RATE GPM/1000 CFM

Fig. 4: Water rates compared with inlet dust loads. This and Fig. 3 refer to Doyle type.

Aerosol Solubility

When scrubbing soluble dust and fume particles such as some paper mill fumes, some furnace fumes, etc., considerable benefit may be obtained by use of this sensible heat condensation treatment. In many cases, fairly high efficiencies can be obtained when treating low

(Please turn to page 40)

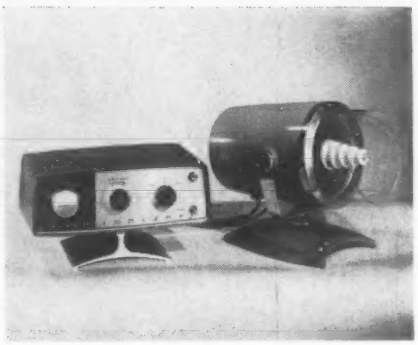
INDUSTRIAL DUSTS AND FUMES
DOYLE SCRUBBER PERFORMANCE

Adaptations Dust Source	*Temperature °F*	*Pressure Drop Inches VWC*	*Removal—% Weight Basis*	*Number of Stages*
Acid Agitator Vent System containing acid mist, fluorides and dust fines	175	11.1	99.2 F 99.4 P_2O_5	Two
Acid Filter Ventilation	85	8.3	98.8 F	Single
Coal Dryers	125	9.0	98.5	Single
Fertilizer Agitator	150	8.6	98.0 F 98.7 P_2O_5 98.8 NH_3/N	Single
Fertilizer Dryers	125	22.4	99.4 F 99.7 P_2O_5	Two
Fluorine Stripper	95	15.0	99.5 F	Two
Hydrofluosilicic Acid Manufacture	210	10.0	97.0 F	Single
Phosphoric Acid Plant	150	17.0	94.2 P_2O_5	Two
Phosphate Rock Dryer	140	8.2	97.4	Single
Precipitated Lime (Paper Plant)	210	20.0	91.0	Two
Pulverized Coal Fuel Fired Boiler	410	10.0*	98.4	Single
Pyrrhotite Suspension Roaster	465	12.1	96.3	Single
Rotary Lime Kiln	350	10.0	98.	Single
Secondary Lead Blast and Reverberatory Furnaces	120	11.0*	85.6	Single
Sodium Silicate Product Ventilation System	150	8.5	97.6	Single

**Test Unit*

New PRODUCTS

Portable Ionitron 5000



Model RG-3 Research Ionizer

New Line Of Ionization Products

Purpose: Philco Corp. announces a line of four ionization products for both the commercial and scientific research markets.

Features: Two types of negative air ion generators are available to the consumer market for, according to Philco Corp., the proven relief of hay fever and other airborne allergies. The first is the Ionitron Air Changer, available for the last few years as an accessory on Philco Room Air Conditioners.

Model IFC-6 Research Ion Counter

Presented for the first time, the Philco Ionitron 5000, a portable unit designed to be carried from room to room.

For scientific research, two pieces of laboratory equipment have also been announced. The Model RG-3 Research Ionizer with continuously variable output (either negative or positive ions) to provide up to 1,000,000 ions per cc for treatment of environmental volumes ranging up to 2000 cu. ft. Also available is a companion instrument, the Model ICF-6 Research Ion Counter, for measuring positive or negative air ion concentrations in an environmental space. The ion mobility cut off of this instrument is nominally set at 0.05 cm/sec/volt/cm but is adjustable to permit a survey of the mobility and size distribution of the ions being counted. A recorder permits a continuous record of ion counts.

For more information circle #71 on page 35 reply cards.

Hermetic Condensing Units

Purpose: From the air conditioning division of Westinghouse Electric Corp. for use in field assembled commercial and industrial air conditioning equipment.

Features: In ratings from 20 to 60 tons, Model CNU has suction operating temperatures from 20° to 50°F. Temperatures outside this range are available.

There are six voltage ratings at three phase, 60 cycles: 208, 220, 240, 440, 480, and 550; at three phase, 50 cycles, three ratings: 220, 380, and 400. All units equipped with either line-start or part-winding-type starters.

Condensing unit consists of complete factory assembled water-cooled condenser, hermetic compressor, and control center. Starters, safety controls, gauge panel, all internal control, and power wiring included as standard items.

Circle #72 on page 35.

Tear Resistant Vinyl-Coated Nylon

Purpose: Fabrication of air-supported buildings, shelters for missiles, aircraft, storage, and public assembly.

Features: According to Farrington Mfg. Co., the new "Mark X" vinyl-coated nylon has ten times the tear resistance normally obtained from fabrics the same cost and weight.

Circle #73 on page 35.

Lightweight Sound Meter

Purpose: Measuring noise levels in any location. Manufactured by H. H. Scott, Inc.

Features: Measures 2 in. x 3 in. x 6 in., weighs 2 lbs., operates on 22.5 volt battery with operating life of 30 hrs. Range of operation is from 35-142 db sound level and 40-8000 cps response. Heavy gauge aluminum case with Rochelle salt diaphragm-type microphone.

Price $150.

Circle #74 on page 35.

Overhead Gas Unit Heater

Purpose: For maintaining uniform room temperature in stores, small buildings, etc., and areas where a negative pressure is created by standard exhaust fans. From John J. Nesbitt, Inc.

Features: Safe operation, no open flame is exposed to room. All combustion air is drawn from outside building through separate inlet pipes. All exhaust gases vented to outside through separate pipe.

Nesbitt Sealed/Flame Unit available in two models. Radial-Flo distributes circle of warm air downward and outward. Down/Blo forces air directly downward.

Two sizes available with inputs of 115,000 Btu per hr. and 85,000 Btu per hr. Can be mounted in either flush-to-ceiling or non-flush position.

Circle #75 on page 35.

Cabinet Blowers

Purpose: Capacities of K Series cabinet blowers have been increased by Reznor Mfg. Co., permitting their use in higher-capacity heating and cooling systems, and use of longer duct runs in systems incorporating the blowers.

Features: Model KI (single blower) in capacities from 2000 to 9000 cfm. Model K2 (two blowers) in capacities of 4000 to 15,000 cfm.

Both models with 7½ hp motor, housed in vibration-free, heavy gauge steel cabinets. Matching filter cases may be ordered as independent sections or as companion sections for the blowers.

Circle #76 on page 35.

Disposable Air Filters

Purpose: According to Barnebey-Cheney Co., the economical answer to most odor problems in forced air ventilating systems.

Features: Gridwork of activated charcoal coated fiber strips in paperboard frame. Lightweight, low resistance to air (.04 at 300 fpm), installed and disposed without mechanical change.

Available in all standard sizes with or without dust media. Can be constructed to meet any specifications.

Circle #77 on page 35.

Single Bank, Balanced Flow Surface Condensers

Purpose: S-1000 surface condensers, from American-Standard Industrial Division, adaptable to small turbine drives in applications as centrifugal compressors in air conditioning, auxiliary generators, pump or blower drives, and standby units.

Features: Covering a range from 200 to 10,000 sq ft, pre-engineered components permit the selection of shell diameters (15 through 48 in.); and practical tube length; two tube sizes (⅝ and ¾ in.);

(Please turn to following page)

PHOTOGRAPH COURTESY OF WESTERN ELECTRIC COMPANY

Angelica Uniforms and Victor Gloves Help Prevent Clean-Room Contamination

Victor Monofilament Nylon Gloves

Angelica has been appointed the only distributor of Victor Gloves, the finest protective gloves made. Victor's non-contaminating gloves of monofilament nylon with plastic coated palms, have maximum touch sensitivity for precision operations. Victor Gloves Inc. collaborated with Bell Laboratories, Inc., in developing these gloves and Bell is currently using them in the assembly of select devices sensitive to physical and chemical contamination.

Other models include ambidextrous gloves and gloves for LOX parts.

Static-Free Dacura* Uniforms

Angelica's coveralls and frocks, of comfortable moisture absorbent Dacura (Dacron** polyester and rayon), are non-linting, acid resistant and static-free. The tight weave of continuous filament yarns resists passage of contamination from the skin or undergarments.

There is a complete "engineer designed" line of Dacura, Dacron, or nylon uniforms and accessories by Angelica and Victor Gloves Inc.

Mail this coupon to the nearest Angelica office below.

*Reg. T.M. H. P. Ogden Co.
**Reg. T.M. of Dupont

Angelica®
UNIFORM COMPANY

1427 Olive St., St. Louis 3, Mo.
107 W. 48th St., New York 36, N. Y.
177 N. Michigan Ave., Chicago 1, Illinois
1900 W. Pico Blvd., Los Angeles 6, Calif.
317 Hayden St., N. W., Atlanta 13, Ga.

Send literature on White Room Uniforms and Gloves.

Name_____ Title_____

Company_____

Address_____

City_____ Zone___ State_____

[For more information circle #26 on page 35 reply cards]

New PRODUCTS

(Continued from preceding page)

1, 2, or 4 pass arrangements; and six water box design pressures (30 through 300 psi).

Condensers designed that user can pipe up and mount air removal equipment on either side of unit.

Shell and tube sides designed for working temperatures of 150°F. Shells reinforced to withstand operation under full 30 in. Hg vacuum or 15 psig pressure.

Circle #78 on page 35.

Outdoor Air Cooled Refrigeration Systems

Purpose: Completely packaged and designed to withstand all weather conditions.

Features: The Kramer Trenton systems are instrumented, tested, and run-in before leaving the factory. They are lightweight and require no heavy structural supports.

Circle #79 on page 35.

Horizontal Double-Fan Discharge Cooling Tower

Purpose: New size economy model has been introduced by Halstead & Mitchell Co.

Features: Nominal rating of 120-tons, based on capacity of 360 gallons of water per minute, at 95°F entering water temperature, 85°F leaving water temperature, and 78°F wet bulb temperature.

Cabinets made of electrically-welded 14-gauge steel and may be ordered in 10-gauge steel.

Circle #80 on page 35.

Automatic Relief Valve

Purpose: Mansfield Sanitary, Inc. announces relief valve for temperature-pressure protection for hot water tanks and heaters.

Features: The Mansfield 503 is constructed of heavy red brass, with test lever, stainless steel control spring, 6 in. exposed extension tube, and special bibb washer. An oversized 8/16 in. seat opening provides instant relief while 3/16 in. flow passage prevents liming or possible obstruction.

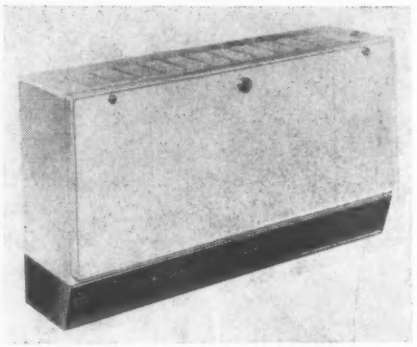
The 503 has ¾ in. inlet and outlet. Standard pressure setting is 125 psi with other settings available. Steam rating is 80,000 Btu.

Circle #81 on page 35.

Cabinet Unit Heaters

Purpose: According to Modine Mfg. Co., new line designed for easy installation and maintenance.

Features: Offered in 136 models, 17 types in eight sizes, and seven



colors. Free-standing, wall or ceiling mounted, and recessed installation, with push-button lubrication, and front drawer filter unit.

Air delivery capacities range from 250 to 2000 cfm.

Circle #82 on page 35.

Spark-Proof Cast Aluminum Fans

Purpose: To be used with Aget Manufacturing Co. "2000 Series" of dust collectors.

Features: Cast from heat treated alloy, light weight, with position moulded blades.

Circle #83 on page 35.

Thermostatic Radiator Steam Trap

Purpose: Designed for applications on radiators, announced by the Mil Division of Parris Engineering Corp.

Features: Forged bronze body and all internal parts stainless steel for corrosion resistance and high strength. Available in ½ in. and ¾ in. sizes. Body patterns include angle and straight-way as well as the Angle-Union which complies with the standard radiator trap configuration.

Circle #84 on page 35.

Relative Humidity Recorder

Purpose: Moderately priced, direct-reading recorder manufactured by Taylor Instrument Co.

Features: Hand portable or wall mounted. Records dry-bulb temperature on same chart as relative humidity. Measurement limits for relative humidity are 0 to 100 percent, for temperature from 0 to 100°F.

Four models available. Weighing 25 lbs, recorder provides for a 12-in. chart record over a 24-hour period.

Circle #85 on page 35.

New Highly Efficient Air Filter

Purpose: Air sampling, industrial filtration, and special high efficiency air filtering units.

Features: According to Gelman Instrument Co., the filter is 99.998 percent efficient on aerosols of .3 micron in diameter. Made of microfibers of polystyrene and air laid down on a continuous belt.

Circle #86 on page 35.

"Torrivent" Line Expanded

Purpose: The Trane Company has announced the expansion of the "Torrivent" line to 17 basic sizes.

Features: Six models are available: horizontal ceiling; horizontal floor; vertical floor; vertical wall; inverted ceiling; and inverted wall. Heating capacities from 20,000 to 3,800,000 Btu and air capacities from 600 to 54,000 cfm.

Circle #87 on page 35.

New Voltage Testing Kit

Purpose: Pyramid Instrument Corp. has released a new testing kit that measures voltage, amperage, and resistance.

Features: Completely insulated, pocket-sized for hand operation, measures current without interrupting service. It measures 4¾ in. high and weighs 11 ounces.

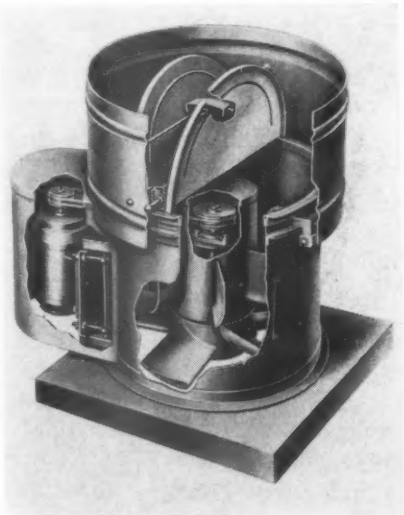
Six different models are available; from 0-25 to 0-100 amps; either 0-125/250 or 0/150/600 volts AC; and an ohmmeter scale with a mid-range reading of 25 ohms.

The kit is priced at $29.85.

Circle #88 on page 35.

Belt-Driven Power Roof Ventilators

Purpose: Installations where hot, moist, corrosive, or fume-laden air is exhausted. Produced by L. J. Wing Mfg. Co.



Features: All-welded construction, blades of true airfoil section; sealed, pre-lubricated self-aligning fan bearings; nylon damper hinge bearings; weatherproof motor housings; hinged discharge for easy access; and leakproof, light-proof dampers. Corrosion-resistant metals or special protective coatings are available.

Ventilators available in twenty sizes and free air capacities from 2000 to 60,500 cfm. Capacities at ½ in. static pressure range from 1350 to 53,000 cfm.

Circle #89 on page 35.

Centrifugal Dust Collectors

Purpose: Series of dust collectors developed by the Torit Manufacturing Co. for handling dust, chips, shavings, metals, plastics, and flour-type materials.

Features: Capacity of Series No. 20-3 (3 hp.) ranges from 1,250 to 2,000 cfm, and the No. 20-5 (5 hp.) to 2,500 cfm. Variations of separators include, after filters for indoor exhausting and enlarged dust storage and hopper capacities. A total of 12 models are available.

Circle #90 on page 35.

Do-It-Yourself Make-Up Air System

Purpose: From Metals Engineering & Mfg. Co., Inc., to convert make-up air system from steam or hot water to gas-fired, or to utilize salvage from air-moving installations into a gas-fired system.

Features: Standard Sun-Flo burner sections with Maxon's "H" line burners, equipped with controls and panels wired and piped for installation. Burner sections may be horizontally or vertically mounted, with nine sizes available in Btu/hr capacities ranging from 1,875,000 to 6,000,000.

Fan capacities, when furnished with burner sections, range from 20,000 cfm to 60,000 cfm.

Circle #91 on page 35.

Axial Flow Fans

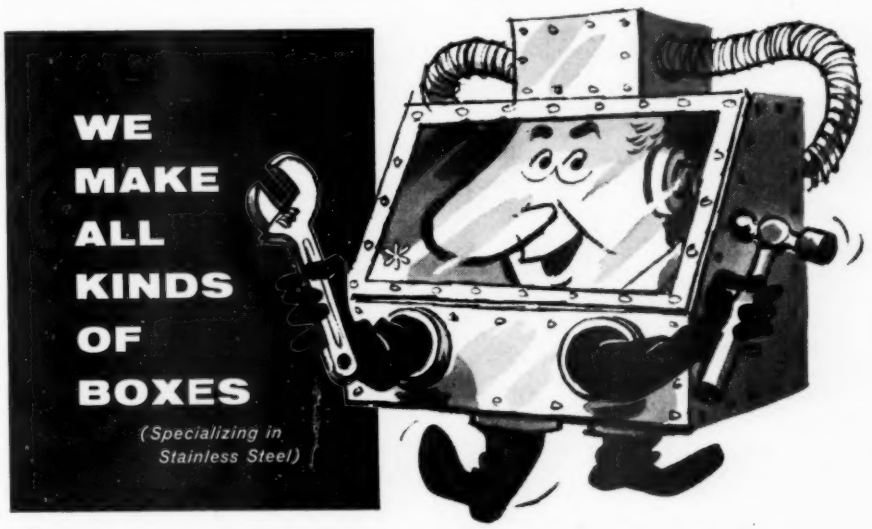
Purpose: According to Mainstream Company, particularly effective in medium static pressure ranges.

Features: Fans from 10 to 28 in., rated up to 15,000 cfm. Plastic blades in choice of four pitches, gripped in an aluminum alloy hub. Seventy-two models with three to twenty blades.

Non-sparking, working temperatures @ 1450 rpm; -49°F to +210°F. Safe-rated up to 3000 rpm depending on size.

Circle #92 on page 35.

To receive information on any of the New Literature listed on the following pages, circle the item reference number on the postage-free reply cards on page 51, Communications Center.



* Here's the real "inside dope" and we're not referring to the happy young fellow portrayed above. (He's not even a member of our organization)

We are a division of Kewaunee Manufacturing Co., specializing in engineering and production of highly technical equipment and apparatus for research and industry. Our experience and facilities qualify us to custom design and manufacture, or assemble from stock, any of the following types of enclosures: glove, vacuum and dry boxes; dust free enclosures; and controlled atmosphere systems.

That's why we readily say, "We make all kinds of boxes."

For complete information, call or write

K·S·E KEWAUNEE SCIENTIFIC EQUIPMENT ADRIAN, MICHIGAN

4055 Logan Street

[For more information circle #27 on page 35]

New Literature

To receive information on any of the New Literature listed on the following pages, circle the item reference number on the postage-free reply cards on page 35, Communications Center.

Portable Industrial Hygiene Instruments

Group of literature on Union Industrial Equipment Corp.'s complete line of portable industrial hygiene instruments and safety products.

Circle #131 on page 35.

"Insulation Product Information"

Thermal insulations for all types of commercial and industrial requirements, in applications ranging from -400°F to 3000°F, are described in newly revised 64-page catalog from Johns-Manville.

Circle #132 on page 35.

"Industrial Building"

Proceedings of the Industrial Building Congress held in conjunction with the first Industrial Building Exposition, New York, Dec., 1960. Published by Clapp & Poliak, Inc.

Circle #133 on page 35.

Air Conditioning Catalog

Complete listing of air conditioning lines manufactured by Drayer-Hanson Division of Hi-Press Air Conditioning of America, Inc.

Circle #134 on page 35.

"Synthetic Uniform Catalog"

Angelica Uniform Co. has published a new catalog of non-linting, acid-resistant, and static-free garments.

Circle #135 on page 35.

Atmospheric Burners

Provides dimension, specification, engineering data, and ordering information for pipe, wheel, immersion, ring, box, and "U" type burners, atmospheric injectors, and packaged burners from Eclipse Fuel Engineering Co.

Circle #136 on page 35.

"Comfort Guide"

Method of heating and cooling load calculating, including such data as glass, shading, and latitude factors in tabular form and developed by Arkla Air Conditioning Corp.

"Comfort Guide" manual is part of a three-element load estimating package, including a companion pad of 50 heating and cooling load estimation forms and the Arkla Psychrometric Chart.

Three-element load estimating package priced at $2.75.

Circle #137 on page 35.

Recording Instruments

Catalog covers all of Weksler Instruments Corp. recording and controlling instruments for temperature, pressure, humidity, and time-of-operation.

Circle #138 on page 35.

pH Meter Bulletin

Features, applications, and specifications of the Beckman Instruments, Inc. Model G and GS pH Meters.

Circle #139 on page 35.

Packaged Ventilating Fans

Line of easy-to-install, packaged ventilating fans for commercial, industrial, and institutional buildings, is described in a bulletin from Modine Mfg. Co.

Circle #140 on page 35.

"Refrigerant Piping Data"

The new 64-page booklet from the Air-Conditioning and Refrigeration Institute contains information on the basis for refrigeration piping design, including instructions with worked-out examples for application of the tables and charts. Priced at $3.00.

Circle #141 on page 35.

"Air Pollution Manual"

Published by American Industrial Hygiene Association. A 184-page book designed to assist in making available information needed for appraisal of air pollution problems. Prepared by group of specialists whose common fields of concern are industrial hygiene and air pollution.

Circle #142 on page 35.

"Precipitron® Electronic Air Cleaners For Oil Mist Control"

From Westinghouse Electric Corp., booklet describes characteristics of electronic air cleaners and how they can be applied to collect oil mists resulting from the operation of industrial machine tools.

Circle #143 on page 35.

"Impinjet Gas Scrubber"

New catalog describes W. W. Sly Mfg. Co. new Impinjet® Scrubbers for wet cleaning, absorption, or cooling of gases resulting from industrial processes.

Circle #144 on page 35.

"AMCA Standard Test Code For Steam Unit Heaters"

A new Standard Code for testing propeller-type Steam Unit Heaters has been announced by the Air Moving & Conditioning Association, Inc.

Circle #145 on page 35.

Combustion Control Systems

A 32-page guide covering the design and selection with an analysis of the two main groups of combustion control systems, proportioning and metering. Guide from Reliance Instrument Division, Electro-Mech Corp.

Circle #146 on page 35.

(Please turn to page 36)

dential, commercial, and industrial comfort heating problems with Chromalox heating equipment from Edwin L. Wiegand Co.

Circle #155 on page 35.

Electric Combination Safety Starters

Outline dimensions, ordering directions, and pricing information on the General Electric JIC combination safety starters.

Circle #156 on page 35.

"Electrionic® Control Centers"

Specific functions, components, and benefits of Electrionic® control centers are described in brochure from Barber-Colman Co.

Circle #157 on page 35.

Boilers For Low Pressure Heating

Bulletin describing Kewanee Type C-7L Series boilers for low pressure heating of commercial and industrial buildings now available from American-Standard.

Circle #158 on page 35.

Adjustable Pressure Switches

Literature describing a leakproof, adjustable pressure and differential pressure switch for use in fluid systems operating at up to 250 psi is now available from Pall Corp.

Circle #159 on page 35.

Unit Heater Line

New brochure on the Mueller Climatrol Gas Fired Suspended Unit Heater line describing and illustrating many applications.

Circle #160 on page 35.

Air-Cooled Condensers

Bulletin issued by the Westinghouse air conditioning division describes the company's new line of air-cooled condensers in the BUVH series, available in two models, either for horizontal or vertical air flow.

Circle #161 on page 35.

Roof Exhaust Fans

A bulletin from Davidson Fan Co., describing their line of Hyduty Roof Exhaust Fans now available with fiberglass housings in color.

Circle #162 on page 35.

Air Pollution Acralyzers

Bulletin describing Beckman Instruments, Inc. Air Pollution Acralyzers has been published by the Scientific and Process Instruments Division.

Circle #163 on page 35.

Reprints

Directory Of Supplies And Equipment For White Rooms

Listing of products designed for White Rooms, other than conventional air conditioning, fans, blowers, air outlets, etc.

Circle #171 on page 35.

Economics Of Factory Air Conditioning

New accounting methods to prove before buying and installing air conditioning, that the investment will pay off as well or better than any other piece of capital equipment. Price 75¢.

Circle #172 on page 35.

Factory Ventilation

Data on use of three basic make-up air systems, factors influencing sizing, types of equipment, temperature controls, filtering, air distribution, system numbering, and costs involved. Price 75¢.

Circle #173 on page 35.

The Meaning Of Clean Air

By Robert H. Avery, Director, Application Engineering, Cambridge Filter Corp., Syracuse, N. Y.

Authoritative data on design and construction of dust-free "white rooms." Price 75¢.

Circle #175 on page 35.

Special Report On White Rooms

Discusses White Rooms as a market, equipment and supplies used in White Rooms, and White Room marketing channels.

Circle #176 on page 35.

White Room Symposium Papers

Presented at American Institute of Plant Engineering Symposium on Dust Control, Tempe, Ariz., Nov., 1960. Price $5.00 (used for start of new American Assoc. For Contamination Control).

Papers include: Determination And Detection Of Air Contaminants; Environmental Control; White Room—Ultra Precision Instruments; Dust Control And White Rooms; White Room—Electronic Tube Industry; Dust Monitoring In The Super-Clean Room By The Dry Slide Settling Technique; Philosophy Of Dust Control At Autonetics.

Circle #178 on page 35.

CORRECTION

In the June, 1961, issue of AIR ENGINEERING, there appeared an article entitled "New Ways to Ventilate Electrically Heated Schools" by James E. Benedict, P.E., Consulting Engineer. This article and the cover of the magazine were illustrated with unidentified photographs.

Three of the photographs used, including the cover, are of the Wylie E. Groves High School, Birmingham, Michigan, designed and executed by Linn Smith Associates, Inc., Architects and Engineers of Birmingham.

This building is not an electrically heated school as implied by the erroneous use of it in connection with the article. Use of the photographs was not approved by the Architect.

The Groves School is generally heated by a forced hot-water system and ventilated by hot water heating and ventilating units located throughout the building. The library, as illustrated on the cover, is heated and ventilated by forced warm air supplied from a hot water heating and ventilating unit. Design of the system was by Gordon E. Hoyem, P.E. of the architects' office. Mr. Benedict was not connected with this project.

Air Conditioning A Solid Propellant Plant

by **William J. Higgins**
Executive Staff Engineer,
Rocket Power Div.,
The Gabriel Co.

Manufacture of solid propellant fuel for rockets requires close control of temperature and humidity, plus special controls and air delivery layout to go through thick concrete walls.

Right: Two-stage Phoenix sounding rocket designed to boost 11 lb payload 285 miles into space, is made at Rocket Power plant.

ROCKET POWER (Fig. 1), a division of The Gabriel Company of Cleveland, Ohio, manufactures sled rockets, sounding rockets, booster rockets, infrared emitters, starter cartridges, igniters, pilot seat ejection systems, production custom loading of solid propellants and "propellants for tomorrow" at this facility.

Confronted by the numerous air conditioning problems found in solid propellant chemical processing due to temperature and humidity control and also the dangers inherent in handling explosives, the plant designers developed a new concept in explosive manufacturing plant design. Unlike other explosive manufacturing plants that isolate their hazardous operations into widely separated buildings, they decided to incorporate more steel and concrete into two structures, set parallel to each other, separated only by one hundred and fifty feet of open area. These buildings are identified as Line 1 and Line 2.

Line 1, 32,000 sq. ft. of floor area, was designed to house hazardous tasks into operating cells with their necessary remote control rooms, and to provide rooms for the various service departments such as receiving, inspection, stores, lunch room, chemical laboratory, production control, x-ray, inert assembly operations and shipping.

The service departments are separated from the operating cells by remote control rooms which also act as the main building corridors.

These corridors are lined on both sides with 12-in. concrete and steel reinforced walls stressed to withstand 5000 lbs. of explosives. These walls add extra safety to all operating and service personnel.

All hazardous operations in the operating cells are remotely controlled from these rooms. All the operating cells, measuring 15 ft. x 20 ft., are equipped with steel blast or escape doors. Outside walls of the operating cells are of the blow-out type, made up of two inches of cementos board with emergency knock-out panels.

Line 2 was planned to house the most hazardous operations, such as chemical weigh-out, propellant mixing, casting, curing, environmental, tool pulling, final assembly, static firing test stands and control rooms. This building of 30,000 sq. ft. has an earth-fill covering five ft. above the roof in certain areas, and 30 ft. embankment, in addition to heavily reinforced concrete walls (Fig. 2). All walls throughout the complete plant are considered structural walls.

Ceilings throughout the plant are 12 ft. high and roof slabs are eight in. reinforced concrete with a covering of white stone. Preplanned air conditioning duct holes were placed in the roof over each operating cell and support room throughout Line 1 and in certain rooms and cells in Line 2. There are no windows in the plant.

This plant of unique design was planned by the combined efforts of Mr. C. E. Bartley, President of Rocket Power, and Mr. Frank A. Marion, Executive Vice President. Mr. Bartley was the receiver of the 1953 Hickman Award for outstanding contributions to the field of solid propellants, former President of the Grand Central Rocket Company and former Chief Engineer of Solid Rockets at the Jet Propulsion Laboratories of the California Institute of Technology. Mr. Marion has had many years of experience in the architectural design of explosives and solid propellant plants. The result of this vast experience produced a solid propellant processing plant that insured economical construction through modular design, employee safety, and efficient manufacturing and maintenance operations.

Plant designers selected an air conditioning system to meet the most exacting requirements. Humidity, temperature, and air movement had to be controlled within each operating cell, control and support room, independent of each other. The installation of a centralized cooling or heating duct system could not be used because of possible incidents whereby toxic exhaust gases could readily contaminate the entire plant.

Climatic conditions were also considered and climatological data evaluated. The average daytime relative humidity in the Salt River Valley is 30 percent, based on observations at 11:30 A.M. and 5:30 P.M. There are two separate rainfall seasons. The first occurs during the winter months from November to March when the area is subjected to occasional storms from the Pacific Ocean. The second rainfall season occurs during July and August when Arizona is subjected to widespread thunderstorm activity, whose moisture supply originates in the Gulf of Mexico. Spring and Fall months are generally dry, although precipitation in substantial amounts has fallen on occasion during every month of the year.

Beginning with June the summer weather is hot, with thunder showers in the evening. The change from the heat of summer to mild winter temperatures occurs during October. Night-time winter temperatures frequently drop below freezing during the three coldest months. Considering these unusual climatological conditions in the Salt River Valley as well as the inherent problems from occasional excessive humidity, the air conditioning system to be selected would be required to operate continuously. An inside temperature of 80°F is maximum when the outside temperature reaches 110°F. An inside temperature of 70°F is minimum when the outside temperature becomes 25°F. An inside relative humidity has to be maintained less than 40 percent for all air conditioned areas. All other areas are greater than 40 percent and less than 60 percent.

Type And Location Of Equipment

All operating cells in the plant had to have explosion-proof air conditioning equipment, explosion-proof thermostats, and off-and-on switches. Supply air fans for these cells had to be located outside the air stream, and the air stream must be free from all switches or other electrical devices which may cause sparking or arcing. All mechanical equipment is located on the roof over each room.

When the system is operating in any room, the supply air fan must be in operation. Non-explosion-proof installations were installed for non-hazardous rooms. Automatic changeover thermostats are located in each conditioned room together with thermostats, on-off switches, as well as an automatic-manual fan selector switch. To prevent tampering with the thermostat control setting, it is located near the equipment on the roof. Once it is set, room temperature is automatically controlled. A minimum ventilation of 10 cfm per person or 50 cfm per system is required in every cell or room. Supply and return air in the operating cells is not interconnected with that of another cell.

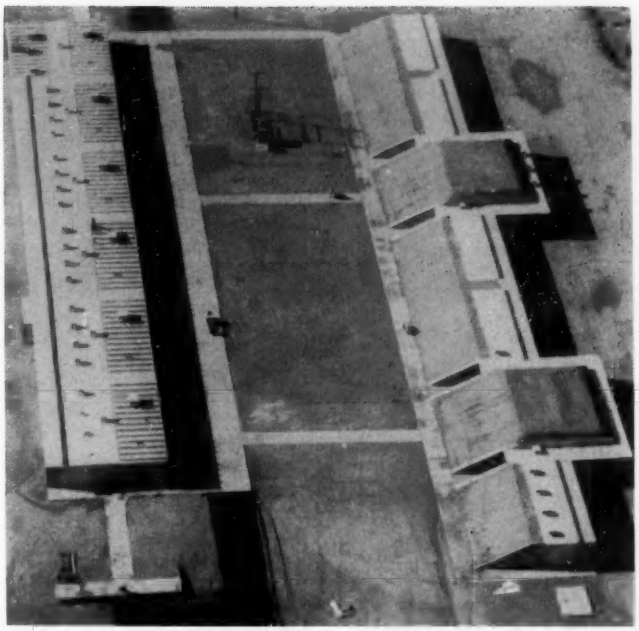


Fig. 1: Aerial view of Rocket Power solid propellant processing plant. Line One is on left, Line Two on right. Earth fill can be seen over most hazardous cells. Air conditioners are on roof of Line One.

The conditioning equipment is complete with automatic defrosting controls, automatic defrosting reverse valve, automatic changeover thermostat and supply air fan control to prevent discharge of below room temperature air during heating or defrosting operation. Each system is sized so that no supplementary electric resistance heating is required.

Heat pumps were selected because operating costs are far below the average. Units selected have an extremely high Coefficient of Performance (COP) and do not require supplementary electrical resistance heat. This reduces operating costs considerably. All Heat Pumps operate on the same basic principle. During the cooling cycle, the unit absorbs heat from the air inside the building and transfers that heat to the outside. During the heating cycle, the unit absorbs heat from the outside air and transfers that heat to the inside. When the outside temperature is near freezing, or below, and there is considerable moisture in the air, the outside coil of the Heat Pump may become covered with frost. This is entirely normal in the operation of the Heat Pump, when on the heating cycle. If this blanket of frost begins to reduce operating efficiency too much, the unit will then go into a defrosting cycle automatically. The fan in the outdoor unit *does not* operate during the defrost cycle and usually the blower fan in the indoor unit will shut off automatically a few seconds after the cycle begins to prevent circulation of cool air.

(Please turn to following page)

(Continued from preceding page)

In-Plant Dust Controls

The heat pump air conditioning system which recirculates the air from the cell or room through the conditioner back into the room requires close dust controls. Therefore, operations that make excessive dust, such as oxidizer weighout, handling and grinding, are provided with localized vacuum type exhaust systems.

These systems are used only when the machinery is in operation. The plant's compressed air system provides the method for creating the necessary vacuum exhaust. Air is piped into a three in. galvanized metal tube downstream from the intake vent. When the compressed air is turned on, it creates a vacuum at the intake, operating similar to a venturi tube. This inexpensive exhaust system is very effective and safe as there are no moving parts. The dust is exhausted into a glass filter bag or into a wet barrel filter located outside the plant.

The control of toxic chemical dust is another problem. At Rocket Power our difficulties do not arise so much from dust entering a working area, thereby contaminating parts or assemblies, but from the necessity of containing the chemicals within a confined area. This problem was solved through the use of glove boxes, performing operations whenever possible within these compartments.

Fig. 2: Roof mounted heat pumps (Mathes) are shown on roof of Line One. Total of 124 tons of refrigeration is provided this plant.

The results obtained from this air conditioning system have made the Rocket Power solid propellant processing plant an ideally climatized facility, both for the employee and for the chemical processing operations. A study of the indoor plant temperatures over a one year period revealed that there is a variance of two or three degrees above or below the required 77° average temperature. Humidity, which is a major problem in propellant processing, has presented no problem here. Although normal desert air is relatively dry, summer and winter rains are often heavy. This type of equipment proves itself at such times. ▲▲

Applications of Wet Scrubbers

(Continued from page 29)

particle size material by this water condensation method.

When a dust or fume particle is completely insoluble, actual contact with the water scrubbing medium, together with what benefit may be derived from condensation, may be considered the only means of wetting a dust particle. When dust and fume particles are much smaller than 2 to 3 microns size, the probability of intimate contact with finely divided water particles is lessened and absorption, envelope or skin effects become important considerations.

Equipment Evaluation

To generalize, wet scrubber collectors are limited to the collection of particulate matter greater than one micron size. Special use of two-stage units utilizing high pressure drops will give effective collection of finely divided aerosols.

The capital cost of low pressure drop equipment is in the range of ten cents to thirty-five cents per cfm for normal materials of construction, to ranges of $1.00 to $1.50 per cfm where special materials of construction are required, or when high pressure shell designs are utilized.

The capital cost of high pressure drop units is quite variable and can range from fifty cents to $1.50 per cfm for normal materials of construction, to as high as $3.50 per cfm and more. This latter high cost figure can reflect a high efficiency design requirement, special materials of construction to abate corrosion, abrasion or other adverse characteristics of the materials being handled.

Impingement Scrubber

The impingement (Doyle) scrubber is a compact unit, of simple design which has no moving parts. Dust and fume laden gases enter top of the unit. Their velocities are increased as they pass through the nozzle-cone section to produce high velocity impingement into the water bath directly below the jet annulus.

This jet action principle creates extreme turbulence, producing a very dense, fine spray mist for cleaning a given gas. The solid particles separated from the gas stream normally form a light slurry which is continuously removed.

Water rates sometimes are determined by the enthalpy change required for pre-determined outlet operating conditions (Fig. 3). Also, Fig. 4 gives water rates compared with inlet dust loads to maintain light slurry flows in the range of 5 percent to 10 percent concentration. These water rates are controlled by means of weir level overflow control or other applicable level control devices. For heavier slurries, a hopper (Fig. 2) is provided for concentrating and subsequent removal for further recovery of solids, if desired.

The scrubber is effective for treatment of wet and dry gases and it has been installed to supple-

(Please turn to page 42)

Integrated Systems

(Continued from page 23)

floor, electrical raceway and a distribution system for supply and return air. The upper ceiling serves as a lighting fixture, a radiant ceiling and an acoustical barrier.

Dual purpose products can be manufactured to modular dimensions and shipped to the building site for erection by the general contractor. Final connections will be made to ductwork, piping, lighting and power systems by the respective trades. In this way significant code requirements can be designed into the product and jurisdiction problems between building trades eliminated.

In part I of this series, static and dynamic integration were defined. In the example illustrated in Fig. 1, dynamic integration is achieved by the design of dual purpose products which are common to two or more building systems, permitting the direct interaction of system energies in such a way as to *increase the efficiency and/or reduce the net energy requirements of the building systems.*

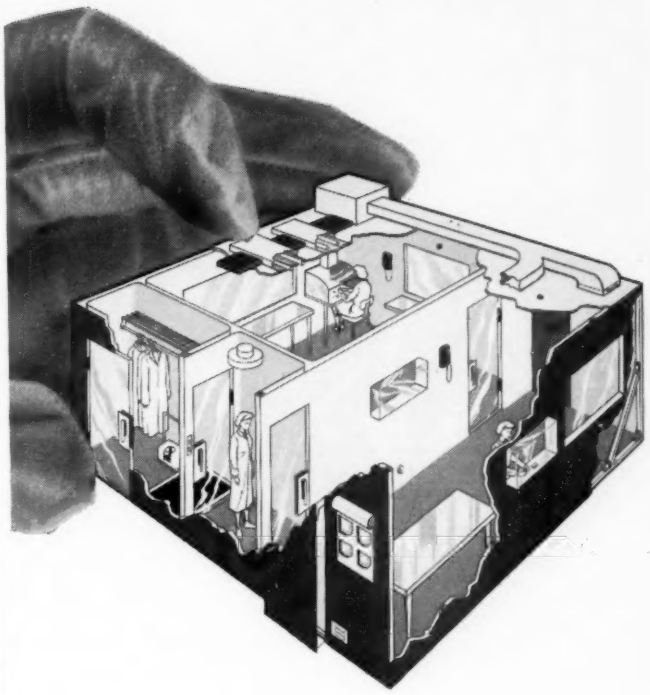
Our test data indicates that the building fluorescent lighting system which generates both light and heat by radiation normally in a 1 to 5 ratio, excluding ballast, can be made to *improve* its light producing efficiency by radiant control of the bulb surfaces. From our laboratory tests, using an integrated luminous ceiling, we noted that by proper control of the lower radiant ceiling we were able to increase the normal measured lumination at the desk level by 3.5 percent while simultaneously reducing the electrical input to the lighting system by 5 percent. The interaction of building system energies serves to demonstrate that dynamic integration of the lighting and air conditioning systems is possible when load sources are controlled by mechanisms (i.e. radiation) which directly affect their efficiency.

The Radiant Air System utilizes cellular air floor as an integral component of the mechanical-structural-electrical and lighting systems. As a structural member, cellular air floor is a load bearing subfloor. As a component of the building electrical power system, it serves to provide raceways for equipment, lighting, signal, telephone, and security services. As a component in the mechanical system, it serves to provide uniform distribution of supply and return air to the conditioned space.

To be truly effective, the cellular floor must satisfy the following requirements:

1. **Be capable of conveying all supply and return air consistent with present and future occupancy requirement.**
2. **Serve only to distribute air with no limitations imposed by temperature control of supply air.**
3. **Capable of complete electrical cell flexibility independent of all cell usage.**
4. **Reduce cubage in multi-story buildings.**

(Please turn to page 43)



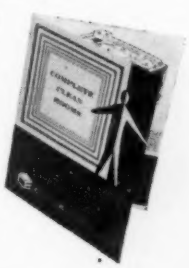
COMPLETE CLEAN ROOMS

• DESIGNED • INSTALLED
• ONE PACKAGE • ONE PRICE

When you need super clean facilities for manufacturing, assembling or testing, investigate CE "Complete Clean Rooms" before you undertake to act as your own designer, engineer and general contractor.

The total cost of a CE installation is almost always less; you get assured performance to fit your specifications; you start operation on a fixed schedule; and you save executive and engineering time by dealing with one supplier.

Write for bulletin "Complete Clean Rooms" which outlines the scope of CE service and includes thirty-one constructional and operational details of a typical CE Clean Room.



Controlled Environment, Inc.
915 GREAT PLAIN AVENUE, NEEDHAM 92, MASSACHUSETTS

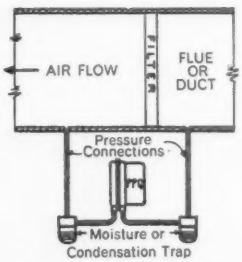
[For more information circle #28 on page 35]

IS THIS YOUR
FILTER
CONTROL
PROBLEM?

1. *To indicate a change in resistance through a filter due to a clogging of the filter.*
2. *To indicate a change in differential across an orifice due to a change in air flow conditions.*

HERE'S THE SOLUTION

Specify a Mercoid Type PPQ Differential Pressure Control. Available with a sp-st mercury switch to operate from the difference in two pressures, or with two sp-st mercury switches, with one switch operating due to an increase in pressure difference and one switch operating due to a decrease in difference.



Illustrated above is a standard application whereby the Type PPQ functions to open (or close) an electrical circuit from a variation in pressure differential due to a clogging filter.

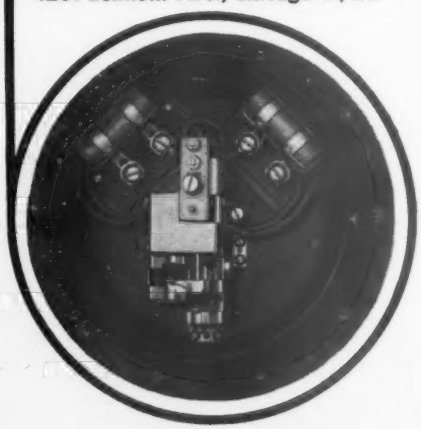
This control can also be used to indicate an unbalanced condition of two air ducts.

RANGES AVAILABLE

Control Range	Switch Range Operating Difference Adjustable Between
INCHES OF WATER	
6.0" Vac. to 6.0" Press.	0.03" to 2.0"
30.0" Vac. to 30.0" Press.	0.2" to 12.0"

Write for Bulletin CA-3P

THE MERCOID CORPORATION
4201 Belmont Ave., Chicago 41, Ill.



[Circle #29 on page 35]

Industrial Heat Exposure

(Continued from page 26)

lost through evaporation of moisture on the skin surface. Heat is never gained but always lost by the evaporation process. The amount of heat that must be lost through evaporation in order to maintain body heat balance is called the required evaporative heat (E_{req}), and is dependent, of course, on the amount of heat put into the body from the metabolism (M), radiation (R) and convection (C). The heat balance equation can therefore be written as— $E_{req} = M \pm R \pm C$.

Metabolic heat rates can be taken from Table 1 while radiant heat and convective heat must be calculated as shown in the sample problem.

To comment or make suggestions about any article in this issue, use the Editorial comment card on page 35.

Wet Scrubbers

(Continued from page 40)

ment conventional collection equipment such as cyclones, etc. for increasing overall efficiency of an installation. Pre-conditioning of inlet gases usually is not required. However, for certain applications where temperatures are extremely high or where the particle fineness of the dust presents a difficult removal problem, the inlet gases may be pre-conditioned by water sprays, steam or ionization by electrical discharge.

During the development of this scrubber, many tests were performed and a great deal of empirical information was gathered and applied to the mass-transfer mathematical relationships applicable to its operations. Much of this performance, efficiency and collection data is based upon actual tests under various operating conditions. The following items give some of the factors that are considered in the design and operations of this impinger scrubber:

1. Close contact between gases and liquid scrubbing medium.
2. Direct impingement of gaseous and particulate matter into water or scrubbing liquor medium.
3. Density and viscosity of scrubbing liquid.
4. Mass-velocity of entering particulate matter suspended in entering gases.
5. Number of stages or series of impingement sections, i.e., one-stage, two-stages, etc.
6. Changes in gas velocities throughout the unit and baffle arrangement of mist eliminator section.
7. Water or liquid flow rates compared to gas flow.

Some of the various operating factors which affect overall performance and efficiency of this scrubber are:

1. Temperature and cooling effects
2. Inlet and outlet dust and fume loadings
3. Dust and fume particle size and distribution
4. Other physical characteristics of the particulate matter
5. Chemical composition of the particulate and/or gaseous constituents being scrubbed
6. Physical and chemical characteristics of the scrubbing medium
7. Efficiency requirements
8. Economic evaluation of the power requirements.

Collection efficiency data is normally expressed as weight collection percentage, and is somewhat dependent upon particle size distribution as generally obtained from analyzing industrial dusts and fumes.

To generalize, 98 percent overall collection efficiency may be obtained with this scrubber under the following conditions:

Capital cost figures for standard scrubber units based upon outlet volume conditions of normal temperature and pressure (NTP) are presented in the following tabulation. The price ranges given are for equipment sizes pictorially represented by Fig. 1. The lower value is indicative of the larger sizes and the higher value is representative of the smaller units. ▲▲

Integrated Systems

(Continued from page 41)

One of the most significant features of using cellular air floor with the Radiant Air System is that temperature control is kept completely out of the floor. It is necessary only to supply constant temperature air with sufficient capacity for humidity control and ventilation. All other variations in space load are reflected on the radiant panels.

Consider the case of individual offices arranged at the building perimeter and served from a common air zone. Variation in occupancy, or internal and external heat gains or losses would require different supply air temperatures to each room. In any type of air system, where cellular air floor is used for distribution, temperature control must be provided as an integral part of the air floor distribution.

Consider next the savings in material for stairs, elevator cables and rails, escalator equipment and vertical risers for plumbing, heating, air conditioning, wiring – in fact every mechanical, architectural, and electrical building component that is installed from floor to floor. Spandrel areas between windows are reduced. Wall building materials, masonry, metal curtain walls or all three can be substantially reduced. In addition, the structural savings resulting from the reduced dead weight of these materials can reflect a *real cost savings in the foundation and footers.* These savings in turn are reflected in a decrease in the size of the mechanical equipment used to condition and control environment.

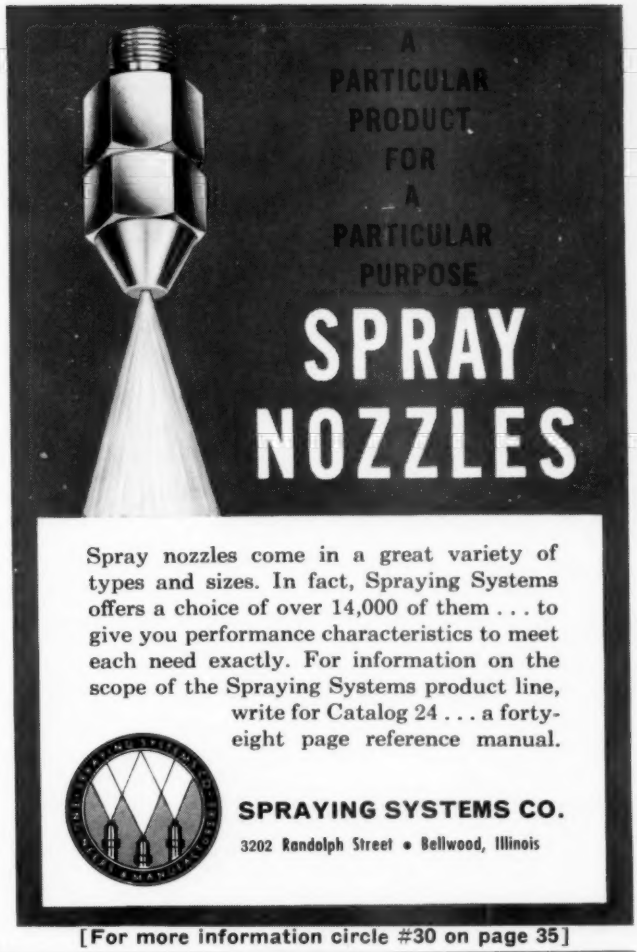
A savings in building volume of 5 percent means that a 19-story office building, using conventional High Pressure Conduit systems, would be equivalent in height to a 20-story office building of the same construction using a Radiant Air System. With 13 ft between floors, a 5 percent savings in building volume represents the equivalent of one extra floor every 20-stories. ▲▲

PRODUCT CREDIT

The significant consequence of the integrated radiant air system is the utilization of Inland Steel Products Co. H_1F and N_1F Celluflor to serve a dual purpose as a component of the mechanical and electrical systems. As structural members Inland Steel Products Co. H_1F and N_1F Celluflor section are load-bearing subfloors.

As a component of the building's electrical system, the N_1F Celluflor serves to provide raceways for power, lighting, signal, telephone and security services.

As a component of the mechanical system, the H_1F Celluflor serves to provide uniform distribution of supply and return air to the conditioned space.


A PARTICULAR PRODUCT FOR A PARTICULAR PURPOSE
SPRAY NOZZLES
Spray nozzles come in a great variety of types and sizes. In fact, Spraying Systems offers a choice of over 14,000 of them . . . to give you performance characteristics to meet each need exactly. For information on the scope of the Spraying Systems product line, write for Catalog 24 . . . a forty-eight page reference manual.
SPRAYING SYSTEMS CO.
3202 Randolph Street • Bellwood, Illinois

[For more information circle #30 on page 35]

SPECIAL CHAIRS FOR WHITE ROOMS AND DUST FREE AREAS
• All Enclosed Mechanism
• No Oil or Grease
• All Chrome Plate Finish
• Easily Cleaned
• 12 Ga. All-Steel Seat; 14" x 15¾"— Waterfall Form. Sand Blast Surface. Adjusts 18" to 26".
• 12 Ga. Steel Backrest; 6" x 13¾"—with tempered steel backrest support. 6 inch horizontal adjustment. Backrest folds down to make easy cleaning.
• Cast Iron Base; 20-inch spread. 1¼" steel glides.
Other White Room chairs with lacquered plywood seat and backrest.
FREE TRIAL Use an AJUSTRITE chair for 30 days without obligation. Prove to yourself the many advantages AJUSTRITE offers in comfort, utility and economy. Write today—we'll do the rest.
10 YEAR GUARANTEE
Model CSSC-1826-CP
JUST LIFT SEAT TO DESIRED HEIGHT
32 Models for Factories • Schools • Laboratories • Hospitals • Offices
AJUSTRITE CHAIRS AND STOOLS
AJUSTO EQUIPMENT CO.
Bowling Green, Ohio

[For more information circle #31 on page 35]

INDEX OF ADVERTISERS

Aerotec Industries, Inc. ..... *
Agency: Doremus-Eshleman Co.

Aerovent Fan Co., Inc. ..... *
Agency: Mariva Industrial Advertising

Air Devices, Inc. 18
Agency: The Powerad Co.

Ajusto Equipment Co. 43
Agency: Blaco Advertising Agency

Alnor Instrument Co., Div. of Illinois Testing Laboratories, Inc.. *
Agency: Kreicker & Meloan, Inc.

American Air Curtain-(Division of Universal Match Corp.) 16
Agency: D'Arcy Advertising Co.

American Air Filter Co., Inc.....Inside Front Cover
Agency: Doe-Anderson Adv. Agency, Inc.

American Brattice Cloth Corp..... *
Agency: Tri-State Advertising Co., Inc.

American-Standard, Industrial Div.. *
Agency: Ross Roy-BSF&D, Inc.

Angelica Uniform Co. 31
Agency: Industrial Advertising Co., Inc.

Bacharach Industrial Instrument Co. *
Agency: W. S. Hill Co.

The Baker Co., Inc. ..... *

Barnebey-Cheney Co. ..... *
Agency: Odiorne Industrial Advertising, Inc.

Buell Engineering Co., Inc..... 15
Agency: Hicks & Greist, Inc.

Buffalo Forge Co. ..... *
Agency: Melvin F. Hall Adv. Agency, Inc.

Burke and Co. ..... *
Agency: Milton Carlson Co.

The Burt Mfg. Co. 19
Agency: McDaniel-Fisher & Spelman Co.

Cain & Co. ..... *
Agency: Shaw Advertising

Cambridge Filter Corp. ..... *
Agency: Richards & Weiss, Inc.

Carnes Corp. ..... *
Agency: Van Handel Advertising Agency

Carpart Corp. ..... *

Carrier Corp. 17
Agency: N. W. Ayer & Son, Inc.

Catalytic Combustion Corp. 4
Agency: Tobias, O'Neil & Gallay, Inc.

The Ceilcote Co., Inc. 11
Agency: Penn & Hamaker, Inc.

Central Scientific Co. ..... *
Agency: Marstellar, Richard, Gebhardt & Reed, Inc.

Chemical Construction Corp., Gas Scrubber Div. ..... *
Agency: Van Brunt & Co.

Clean Tread Div., Merit Paper & Chemical Corp. ... *

Connor Engineering Corp. ..... *
Agency: William Schaller Co., Inc.

Controlled Atmosphere Enclosures Mfg. Co., Inc. ..... *
Agency: C. J. Herrick Associates

Controlled Environment, Inc. 41
Agency: Culver Advertising, Inc. and Walter B. Snow & Staff

The Ducon Co., Inc. ..... *
Agency: Sam J. Gallay Advertising

E. I. du Pont de Nemours & Co. (Inc.), Textile Fibers Dept. ..... *
Agency: Batten, Barton, Durstine & Osborn, Inc.

Dustex Corp. 13
Agency: Comstock & Co.

F. W. Dwyer Mfg. Co. ..... *
Agency: Symonds, Mackenzie & Co., Inc.

Eclipse Fuel Engineering Co. ..... *
Agency: Howard H. Monk & Assoc., Inc.

Englehard Hanovia, Inc. Hanovia Lamp Div. ..... *
Agency: Stuart Sande, Advertising

Fashion Seal Uniforms ..... *
Agency: Charles J. Charney & Co.

Folger Adam Co. ..... *
Agency: Kenneth B. Butler & Associates

Genie-Air Products, A Div. of the N.T.W. Corp. ..... *
Agency: Dozier Eastman and Co.

Hartzell Propeller Fan Co. 12
Agency: Kight Advertising, Inc.

Heil Process Equipment Corp. ..... *
Agency: Henry T. Bourne Adv.

Hoffman Industries, Inc. .....Inside Back Cover
Agency: Mohr & Eicoff, Inc.

Industrial Acoustics Co., Inc. 1
Agency: Ritter, Sanford, Price & Chalek, Inc.

Jackson & Church Div., York-Shipley Inc. ..... *
Agency: Adams Associates, Inc.

Kewaunee Scientific Equipment..... 33
Agency: Phillipps-Thackeray Advertising

The Kirk & Blum Mfg. Co. ..... *
Agency: Baer, Kemble & Spicer, Inc.

Koppers Co., Inc. ..... *
Agency: VanSant, Dugdale & Co., Inc.

Leitch-Huard Corp. ..... *
Agency: Weston Associates, Inc.

Liberty Machine Co. ..... *
Agency: Basil W. Schwarz Associates

Maxon Premix Burner Co. 6
Agency: R. J. Poorman & Associates, Inc.

The Mercoid Corp. 42
Agency: V. S. Krale

Mine Safety Appliance Co. ..... *
Agency: Ketchum, MacLeod & Grove, Inc.

Morse Boulger, Inc. ..... *
Agency: Byrde, Richard & Pound

D. J. Murray Mfg. Co. ..... *
Agency: R. C. Breth Inc.

National Heater Co., Inc. ..... *
Agency: Johnson-Livingston Advertising Inc.

Niagara Blower Co. ..... *
Agency: The Moss-Chase Co.

Peerless Electric Div., H. K. Porter Co., Inc. 5
Agency: Meek & Thomas, Inc.

Philco Corp., Lansdale Div. 14
Agency: Maxwell Associates, Inc.

Progressive Engineering Co. ..... *
Agency: Lindeman Advertising, Inc.

Pulverizing Machinery Div., American-Marietta Co. ..... *
Agency: Williams and London Advertising

Research-Cottrell, Inc. ..... *
Agency: Michel-Cather, Inc.

The Spencer Turbine Co. ..... *
Agency: William Schaller Co., Inc.

Spraying Systems Co. 43
Agency: Advertising Producers-Associated

The Staplex Co. ..... *
Agency: Ellington & Co., Inc.

Stoddard Industries ..... *
Agency: Geyer-Morey-Madden & Ballard, Inc.

Torit Manufacturing Co. ..... *
Agency: Kerker-Peterson, Inc.

Travis Fabrics, Inc. ..... *
Agency: Charles J. Charney & Co., Inc.

Union Carbide Development Co..... *
Agency: O. S. Tyson & Co., Inc.

Union Industrial Equipment Corp... *

U. S. Stoneware Co. ..... *
Agency: Ralph Gross Advertising, Inc.

Western Precipitation Div. of Joy Mfg. Co. ..... *
Agency: Hixson & Jorgensen, Inc.

Wheelabrator Corp. ..... *
Agency: The Jaqua Co.

John Wood Co. ..... *
Agency: Pace Advertising Agency, Inc.

Worklon, Inc. ..... *
Agency: Arpadi - Sarett Associates

Worth Chemical Products Co. 2
Agency: Fuller & Smith & Ross Inc.

York Corp., Subs. of Borg-Warner Corp.....Back Cover
Agency: Keyes, Madden & Jones

*Not advertising in this issue.

CLASSIFIED ADVERTISING

RATES—Classified advertising is run in 6-point type (this size) under suitable headings. Minimum rate $5.00 for forty words or less. Extra words .15 each. Box addresses, with usual services, count as five words. Display type ads available. Payment required with order. No agency commission, no checking copies. Closing date first of month preceding month of issue. No proofs will be submitted prior to running, but proof will be forwarded for record. AIR ENGINEERING, 450 W. Fort Street, Detroit 26, Mich.

POSITIONS AVAILABLE

DUST COLLECTING ENGINEER

AAAA Ohio manufacturer is seeking an engineer with a minimum of five years' experience in the application and sales of industrial dust collecting equipment. This is an unusual sales opportunity in a newly created product line. Give full background in letter directed to

BOX AE-76-4612
Air Engineering

MANUFACTURERS' AGENTS — We need many additional agents all over this country to sell a most successful wet dust collector, manufactured and sold in 12 countries besides the U.S.A. We have been in business for 15 years and have the product and the reputation on which to expand our business. Only qualified ventilating engineers need apply. Our agents have been notified of this advertisement. Please reply BOX AE-765-8601, Air Engineering.

NEWS

(Continued from page 19)

trations under adverse weather conditions . . . with significant accuracy."

He said that better control of emissions from combustion processes must be developed not only from generation of heat, power and light, but also from incineration of rubbish in domestic, apartment house and municipal incinerators.

Scoring lay writers who complain without fully understanding all the problems of air pollution control, Mr. Hitchcock said that these writers are frequently indignant "when they discover the expanding research programs on air pollution. 'Never mind the research,' they say, 'let's stop the pollution now.' If a parallel could be found for this illogic, it might be to ask why cancer research continues," concluded Mr. Hitchcock.